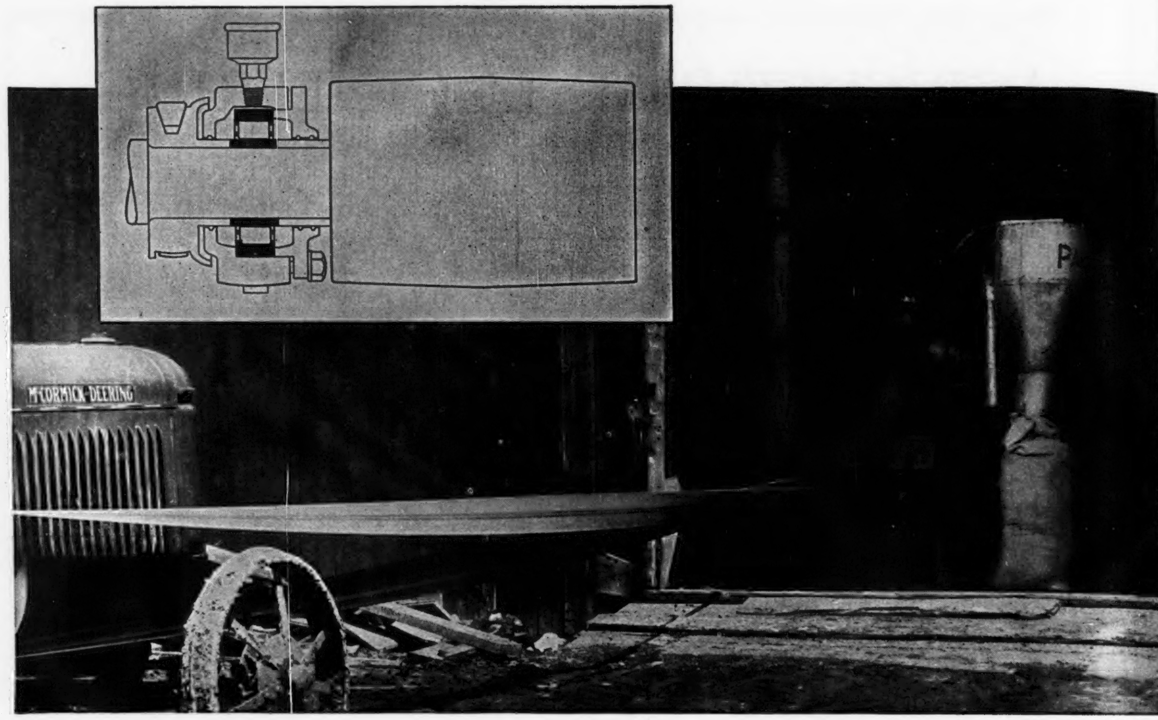
AGRICULTURAL ENGINEERING

Published by the American Society of Agricultural Engineers

Volume 17 | FEBRUARY 1936 | Number 2

CONTENTS

Published monthly by the American Society of Agricultural Engineers. Publication office at Benton Harbor, Michigan. Editorial and advertising departments at the headquarters of the Society, St. Joseph, Michigan . . . . Price $3.00 a year, 30 cents a copy; to members $2.00 a year, 20 cent a copy. Postage to countries to which second-class rates do not apply, $1.00 additional . . . . The Society is not responsible for statements and opinions contained in papers published in this journal; they represent the views of the individuals to whom they are credited and are not binding on the Society as a whole . . . . Entered as second-class matter, October 28, 1933, at the post office at Benton Harbor, Michigan, under the Act of August 24, 1912. Additional entry at St. Joseph, Michigan. Acceptance for mailing at the special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized August 11, 1921 . . . .


McCORMICK-DEERING

AGRICULTURAL ENGINEERING

VOL 17, NO 2 — EDITORIALS — FEBRUARY 1936

Not a Part of the "Farm Problem"

HOWEVER diverse may have been our convictions as to the wisdom of this or that feature in the AAA program, we can agree in the feeling of relief that the suspense and uncertainty are over. While most of its subject matter was not directly of an engineering nature, its ramifications became more and more entangled with agricultural engineering. Wholly apart from political and constitutional questions, and problems of emergency economics, it probably is just as well to unravel the tangled fabric, scrutinize and sort out its varied threads, and create from them a more orderly pattern.

The soil conservation program should be more logically aligned. It should be divested of its emergency and employment aspects, and made to stand squarely on its own feet for what it is, the preservation of an irreplaceable heritage, priceless not alone to agriculture, but to all who hope that posterity may eat. At the same time it should be better correlated with other agricultural measures, notably whatever may be enacted in place of the AAA as a means of protecting agriculture's position in the economic structure.

Yet we are not complimented by the thought, sounded in some quarters, that conservation be made a hook on which to hang legislation primarily of a "relief" nature. Conservation is too vital to the future of America, its program too long, its results too permanent, to be kicked around as an appendage of employment, of farm relief, or of anything else. It should be the dog, not the tail. Other measures should be adjusted to it, not it to them.

If a sound conservation program happens to carry some incidental benefits in the way of short-term economics, well and good. Such advantages might justify acceleration of the program, or certain of its parts, but they should never dominate it. It would be short-sighted opportunism to mix conservation with other matters to the degree that the conservation program will be "up in the air" every time that the shifting winds of economic circumstances and political doctrine call for changes in legislation on more temporary matters. For this reason we hope that, in the reorganization of the agricultural plan, conservation will be kept somewhat apart from other items.

International Agricultural Engineering

THE POINT has been made in these pages that the American Society of Agricultural Engineers long since outgrew the concept of its founders and has become not only a national but an international body. It has now more than a score of foreign lands represented in its membership, though each has but a few, sometimes only one, such member. The exception is Canada, with membership sufficient in numbers and activity to create and carry on a Canadian Section, parallel to the North Atlantic, Southern, Southwest, and Pacific Coast Sections.

So thoroughly has the Canada-United States boundary become an imaginary line, in the thought and work of this Society, that probably few members have taken conscious cognizance that the report of the Nominating Committee, printed in our last issue, includes among the nominees a member from Canada. We are not party to the deliberations of that committee, but we suspect that they, too, were oblivious to national boundaries in setting out the names of eligible and qualified agricultural engineers. Certainly the participation of Canadian members in the work of technical committees, and their appearance on programs, have fortified the feeling that agricultural engineering is geographical only in terms of crops, soils and climates.

Only an accident of geology, or of colonization in relation to geology, keeps the two nations from being much more mutually concerned with problems of land utilization and soil and water conservation. Wise as were the early statesmen of the neighboring commonwealths, we doubt if they took into account such things as erosion and flood control when they drew a 3000-mile line between the drainage areas, respectively, of Hudson Bay and the Gulf of Mexico. Except for that accident, agricultural engineers of the two nations would now be facing problems of joint action comparable to those of power and navigation engineers in the Great Lakes region.

What the future may unfold cannot now be seen, but we know that soil and water management already spans the reaches from headwaters to delta of our greatest streams. It is possible that problems of the future will cut across the national boundary as those of the present transcend state lines. If that time comes, the sister nations will have in the ASAE an agency qualified to deal with them sympathetically and competently.

Col. Lowden on Soil Conservation

"WHEN the soil from which the greatness of the city springs is once impoverished, or the people living on it are reduced to penury, the city will vanish. History records a long line of great metropolitan centers that disappeared because they neglected the countryside which nourished them," said Frank O. Lowden in an interview by the Associated Press late last month.

Long inactive in practical politics and now speaking from the ripe perspective of 75 years, it seems possible to cite his views without political implications. Those views deserve consideration because their background combines big business of the metropolitan type with long farm experience ranging from the humblest "dirt farmer" activity to landed proprietorship. It is enriched with something of a professional career, and with participation in

public affairs more notable for administrative efficiency than for personal or partisan advancement.

As engineers we may pass over his discussion of constitutionality and differ as to the need for reducing "burdensome surpluses," but most of us will concur in such objectives as to "curtail waste and destruction of soil, safeguard the American living standard, insure the future welfare of urban and rural residents alike, and assure coming generations adequate food at reasonable prices." As engineers we may even go further by envisioning the impending market for farm crops as industrial materials, and by advocating such advances in agricultural efficiency as will combine all his objectives with lower food costs and more adequate nourishment for the present generation. As to administrative policy, Col. Lowden says:

"The program of land utilization . . . . should be supervised by the state colleges of agriculture. Through their extension service they now have innumerable agencies reaching into all parts of the states. Through surveys already made or being made they have the requisite knowledge for almost every farm. They know the needs of agriculture in the several states better than any one else . . . . Its administration would be comparatively inexpensive. Only a few more men would be needed."

As quoted by the press, he recognizes the need of correlation of such a program by federal agencies, and suggests grants to the states similar to those for highway construction. We might suggest as a happier precedent the federal support and correlation of research work among the state experiment stations and colleges of agriculture, though the success and efficiency of these activities may not be so impressive as highways to the newspaper reader.

Our long-developed, though lately-crystallized, concept of soil and water conservation surely demands strong leadership on a regional or national basis. The erosion problem in one state is part and parcel of a flood control problem in another state, or of irrigation in still other states. All are interwoven with ground water resources, forest policies, stream control for power or navigation purposes, etc. In the technical aspects of these interlocking matters, the American Society of Agricultural Engineers has proven itself a most useful agency for correlation, and we have every confidence that it will continue and expand as such. For carrying into practice its findings there must be legal authority and financial support, and here the federal government seems the only logical agency.

The fact that Col. Lowden does not approach these questions from the viewpoint of an engineer makes all the more impressive his substantial agreement with our policies, and his endorsement of the agencies through which we have demonstrated our capacity to serve America effectively.

Let the Fit Survive

IN OUR OPINION ASAE President L. F. Livingston set up a concept which will—or at least should—become epochal in our national treatment of agriculture when he proposed that farmers be classified as successful and unsuccessful, and dealt with accordingly. We have long contended that a wise nation will pursue a policy of enlightened selfishness by promoting a prosperous agriculture. He adds that the support of the nation should be predicated on the efficiency of the farmer, not alone in immediate operation, but in acting as steward of the nation's soil resources.

Despite our deep-rooted emotions on the subject of land ownership, and the right of the individual to do as he will with what is his own, it is now all too apparent that a farmer can have no such absolute right unless he can control water on his farm so that no part of it pours in excess onto the farm of another, perhaps a mile or a thousand miles away. He would have to control his soil that none of it may blow and bury his neighbor's crop or befoul a white collar halfway across the continent. Indeed, he would have to govern the transpiration of plants and the percolation of ground water on the premises which he proudly asserts are his alone.

If we admit the doctrine that water resources for navigation and power are the heritage of the whole people, we can do no less with water resources for agriculture. Still less can we deny the public interest in the soil, for it is even more vital to the long-run welfare of our race. In the face of these well-nigh axiomatic considerations, Mr. Livingston's proposal that economic assistance be limited to those farmers who adequately serve the national interest is conservative. His concurrent suggestion that other farmers be segregated and taken care of in some other fashion is both wise and compassionate.

All of this is broader than the scope of agricultural engineering. Yet the subject matter of our profession is so largely involved, and we are in such a position to see the question with more than ordinary vision, that we may properly take the burden of making the principle known and working for its adoption.

Nutritional Levels and Engineering

BOTH because scant attention was given them at the time, and because the trend of affairs makes them not less but more timely, we recall from President Roosevelt's address of November 29, 1935, these words:

"National surveys prove that the average of our citizenship lives today on what would be called by the medical fraternity a third-class diet. If the country lived on a second-class diet, we would need to put many more acres than we use today back into the production of foodstuffs for domestic consumption. If the nation lived on a first-class diet, we would have to put more acres than we ever have cultivated into the production of an additional supply of things for Americans to eat."

Those are not new facts to ASAE members who heard them discussed in the land utilization session of the 1934 annual meeting at Detroit, but they deserve new emphasis in a time of more permanent planning for protection of future productive capacity in agriculture. While consumer income and distribution costs are major factors in the problem of national nutrition, every reduction in unit costs by agricultural engineering helps to narrow the gap between a solvent agriculture and a well-fed populace.

What America's Soil Conservation Program Requires of the Engineer

By F. A. Fisher

THE SOIL conservation program of America is requiring more and more of the engineer as the soil conservation movement gains in magnitude. It is obvious that the engineer who will meet the requirements of the soil conservation movement, must be a true agricultural engineer. This is a branch of engineering for which there is an increasing demand and which will undoubtedly absorb a large number of properly trained men, provided they are available. There will also be a demand for these men to serve as instructors in colleges; to act as extension men under the U. S. Department of Agriculture, whose services reach down through the state extension services and out into the individual counties; to conduct research in colleges and for the Department of Agriculture; and to serve in the employ of commercial organizations such as loan corporations, farm management organizations, and machinery companies.

Cities with artificial lakes as a source of water supply and drainage districts are beginning to recognize that their maintenance problems resulting from excessive silting can be solved only by competently directed soil conservation and erosion control methods. County highway engineers also realize that some of their problems demand the services of a soil conservationist for solution.

Much has been said about teaching the farmer to carry on erosion control work for himself. We consider this the ultimate objective of our program. The individual farmers must carry on the work themselves because the Soil Conservation Service alone cannot furnish labor to do all the work necessary. This statement should not be interpreted to mean that they should be expected to carry on entirely undirected. This may be possible from a soil improvement and farm management standpoint, for the farmer should be able to plan his rotations and apply limestone in order to grow legumes and other erosion-resistant crops for himself and without having constant technical supervision. Control measures involving engineering work are another thing. We have found that, with a few exceptions, the kind and amount of work necessary is usually too extensive for an individual farmer to attempt without some sort of technical supervision. Those farmers who have made an unaided engineering effort to control erosion on their land have too often ignored certain fundamental engineering principles. These mistakes have almost always caused the structural work to result in failure and have also meant the loss of considerable time and money. Had the farmer employed a competent engineer or secured the proper advice and aid from some state or federal agency able to give such service, many of these structures could have been made to serve their purpose well. For this reason, it is my opinion that every county in those states having erosion problems will, in time, find it necessary to employ one or more trained men to help plan and execute soil conservation work in the county. Already 42 of the 102 counties in Illinois have soil conservation associations which have been organized to disseminate information regarding the best methods of erosion control. Membership in these county associations is being required of the farmer at present in order to secure the assistance of the Soil Conservation Service. When the CCC camps are moved or relief labor projects withdrawn, the permanent local soil conservation associations will stand ready to carry on the program inaugurated by the Soil Conservation Service. It is obvious that technical engineering aid will be necessary to guide these soil conservation associations in developing and carrying on this work.

It might be well to consider the training required in order to meet the demands which will be made in this field. Quite often in the past two years we have found that recent graduates in agricultural engineering did not possess the necessary qualifications in surveying, hydraulics, and structural design to meet the requirements of the Soil Conservation Service. Conversely, we have also found that engineers of the other professions lack the necessary agricultural training and background. Please bear in mind that I am speaking wholly from the standpoint of the Soil Conservation Service, with no reference as to what might be required in other specialized lines such as farm machinery, rural electrification, and so forth.

The Soil Conservation Service is in need of engineers having the proper viewpoint and training to aid in doing a job which has long been neglected and now must be done if our agricultural lands are to escape the toll of erosion. It will be the function of the universities to furnish these properly trained men, but if they are to meet the demand

---

Delivered before the Soil and Water Conservation Division of the American Society of Agricultural Engineers at Chicago, December 5, 1935.

Author: State coordinator (Illinois), Soil Conservation Service, U. S. Department of Agriculture.

for this sort of training, they will have to revise some of their rigid graduation requirements as set up in the regular colleges of agriculture and engineering, and devise a combination of courses offered in both these colleges which will include ample training in soils and crops, farm management, structural design, surveying, hydraulics, and the construction and operation of farm and certain types of heavy machinery. It is realized that such a course of training in the necessary fields may take a longer period of study than the usual four years required for graduation. In our attempt to set forth the training which will be required of a qualified agricultural engineer of the future, we must not forget to give a great deal of credit to the spirit and work of the older engineers and agricultural men who are largely responsible for the development of the agricultural engineering profession and for much of the really worth while pioneer work in the soil conservation program.

Soil conservation in America, especially in the north central states, is yet only in its infancy. Consequently, as time passes on, we are continually recognizing problems which did not appear to be in the picture at first. Too often in the past, engineering work which was theoretically and practically sound from an engineering standpoint has been found inadequate because when planned, agronomic factors, which would contribute to its success or failure as an erosion control measure, were not taken into consideration. Therefore, we now recognize that the agricultural engineer doing soil conservation work must be able to clearly see the correlation of engineering with the agronomic, soils, forestry, and economic phases of soil conservation if he is to make his engineering work successful.

RELATION OF CONTROL COSTS TO VALUE OF LAND PROTECTED IS IMPORTANT

The first thing the engineer should be able to do is weigh the problem from an economic standpoint. Illinois soils vary in value from $5 to $150 per acre. For that reason, it becomes important that the engineer consider the relation of control costs to the value of the land protected. Extensive engineering work should not be attempted, unless it can be assured that engineering methods of control will result in a proportionately large increase in crop returns or sufficiently increase the present appraisal value of the original capital investment to justify the expense. Where land is worth $100 per acre, higher engineering costs can be justified than on land worth but $10 per acre. Likewise, the farmer should not invest all his money in one phase of the work, but should balance the expense of all needs of the soil. One camp superintendent wrote in, saying "The farmer spent $200 to terrace a poor, badly eroded field and now has no money to lime it, so he cannot build it up." Had the engineer taken the economic phase of his program into consideration he would have weighed such a possibility and probably had the farmer spent $100 for terracing and $100 for limestone, then the next year, perhaps, the farmer would have been in a position to do the rest of the field. In this particular case the farmer lost any financial benefit he might have derived from the limestone for the first year, thus reducing his income for that period. Due to the advanced stages of erosion, many of our problems are ones of reclamation rather than conservation. The extent to which reclamation of badly eroded land by engineering methods is justified is open to debate. For instance, we feel that on the many steep slopes that should be left or put back into trees, engineering methods of control must play a minor part, because most of the land going back into forest is of low value and it will be many years before returns will be obtained from its reforestation.

In a state like Illinois where soil type varies so widely, fundamental training in soils and familiarity with the characteristics of the principal soil types become extremely important. To illustrate the necessity for this knowledge of soils, it might be well to observe what has happened in different parts of Illinois where soil conditions were not taken into consideration. For instance, in one case in the northern part of the state, a system of terraces was laid out and construction started. All went well until the the third or fourth terrace intercepted a limestone layer which was hidden some ten or twelve inches beneath the surface. When the terracing equipment made contact with the limestone, it was almost impossible to complete the terrace without considerable added expense. Had the engineer a knowledge of the soil in which he was working, he undoubtedly would have suspected trouble from that source and taken steps to determine, by borings, whether or not it was feasible to terrace that particular slope.

DIFFERENT SOIL CONDITIONS PRESENT ENTIRELY DIFFERENT ENGINEERING PROBLEMS

We also find that on certain soil types we are quite often able to block terraces and thus divert considerable water until the outlet has had an opportunity to grass over. This can be done safely only when in possession of a thorough knowledge of the absorptive qualities of the subsoil. If we were to block terraces built on land having a compact subsoil, we undoubtedly would lose a good share of the terrace system due to overtopping. There are places where the soil type makes it possible to build terraces level, whereas on another type of soil the terraces would have to be built with a grade. Along the Illinois and Mississippi Rivers we have the deep loessial soils that present an entirely different engineering problem than is found on the other side of the state where the loessial capping is shallow. In this territory we can use a smaller terrace than in the sections where the soil is more compact. Likewise spacing can be farther apart than where there is a very compact subsoil.

A knowledge of soils is necessary in the construction of soil-saving dams, spillways, etc. For instance, in certain portions of Illinois we have soils that are unsuitable for earth fills. Ground water has often caused considerable trouble at the point where an earth fill joins the original earth bank because of a seepage line that may occur just above an impervious soil stratum.

In the older and more weathered soils in the southern part of Illinois, so-called "slick spots" are found. These slick spots seem to melt away when water is concentrated upon them, and at no time are they capable of supporting vegetation dense enough to be effective in a terrace outlet. It is obvious that the engineer's knowledge of this condition should prevent him from attempting to build vegetative terrace outlets where these slick spots are likely to cause trouble.

The next thing required of the engineer is that he know the practical farming problems of the region in which he is working. Familiarity with individual farming practices is necessary in order to be able to place terraces, terrace outlets, dams, and gully structures so they will function with the least inconvenience to the farmer and his farm plan. There are places where the farmer has been caused considerable inconvenience because the engineer was not familiar with or else did not take the operator's farm plans into account. The engineer must at all times remember that the farmer is going to have to live and farm along with any control measures inaugurated.

As an illustration, two possible outlet locations were found on a certain field where we *(Continued on page 54)*

Terracing Machinery and Terrace Construction Practices

A Symposium

In the Southwest Area

By Ralph W. Baird

IT IS the purpose of this paper to review the equipment and methods used in terrace construction, and to give some consideration to the factors that determine the type of terrace used. My comments will have particular reference to the sections of the Southwest (Oklahoma and Texas) with which I am familiar.

It might be well, first to mention the different machines that have been used in building terraces. Starting with the small machines, we have plows, slips and fresnos, V-drags, special terracing graders, blade road graders, elevating graders, and a few other special machines which have promise, but which have not been generally used. Good terraces have been built with each of these machines, but economical construction has not always been obtained.

Until the last few years most of the terraces built have been built by the farmers themselves with what equipment could be obtained, and comparatively few outfits were purchased primarily for terrace construction. For that reason, construction costs were usually high, if much charge is made for farm labor. With the increase in the amount of terracing being done, there has been a natural increase in the size of equipment used, with a great decrease in the labor required, and a greater number of complete outfits purchased primarily for terracing work.

As I see this problem, we will have two classes of machines to consider. One is the smaller machine adapted to the power the ordinary farmer has available to be used in constructing terraces during slack periods throughout the year. Much terracing work will still be done in this manner. The other class of machines will be those designed primarily for terrace construction, used by governmental agencies or contractors, and with power units selected which will give the most satisfactory and economical performance.

With the first class of machines there is a rather definite limit to the size. They must be of light enough draft that they can be handled with the ordinary farm power. In parts of Oklahoma and Texas this limits size to that handled by a 4-horse team and the largest size would be those that could be handled with a tractor of 15 to 20 drawbar horsepower. In general, machines of this size do not make efficient use of labor, but by doing the terracing work when not rushed with other field work, the terracing job can be done without a great cash outlay.

The other class of machines should be of the type and size to give the most economical construction possible. The size most effective will depend largely upon the terrace cross-section requirement, and size and topography of fields. The cross-section requirements will be discussed in considerable detail, but it is obviously impractical to build narrow terraces with very large equipment. Likewise, where terraces should be constructed largely from the upper side a machine which is not reversible is out of place. In most of the work in Texas and Oklahoma a minimum width of 20 feet from toe to toe of the terrace is considered standard. Graders with a 10- or 12-foot blade are not too large for this size terrace.

In sections where fields are small it is often possible to change the layout of the fields so that terraces of reasonable length can be built. It may be desirable to treat several fields as a unit and terrace across field boundaries where fields are very small. In very few sections will there be many fields where terrace lengths of 1000 to 1500 feet cannot be obtained by careful planning. With terraces of this length or longer, graders with a 10-foot blade or

---

Presented before the Soil and Water Conservation and Power and Machinery Divisions of the American Society of Agricultural Engineers at Chicago, December 5, 1935.

Author: Associate agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. Mem. ASAE.

THE INCREASE IN THE AMOUNT OF TERRACING WORK BEING DONE HAS RESULTED IN AN INCREASE IN THE SIZE OF THE EQUIPMENT USED FOR BUILDING THE TERRACES, TOGETHER WITH A DECREASE IN THE AMOUNT OF LABOR REQUIRED AND A GREATER NUMBER OF COMPLETE OUTFITS PURCHASED PRIMARILY FOR TERRACING WORK. THE COST OF BUILDING TERRACES ON GRADUAL SLOPES FREE FROM GULLIES IS OBVIOUSLY MUCH LOWER THAN ON IRREGULAR SLOPES, WHICH USUALLY HAVE MORE GULLIES AND WHICH NECESSITATE SHORTER TERRACES

larger are practical, and the total time lost in turning is probably no greater than when using smaller machines.

There is considerable question as to the most desirable cross section for terraces. It seems to me that the most satisfactory cross section is the one most cheaply obtained which has proper channel capacity and is of such shape that it will permit the growing and harvesting of the desired crops upon the terrace ridge and in the terrace channel.

The land slope, type of soil, crops grown, and machinery used will determine the most satisfactory section. On steep slopes it seems desirable to move most of the dirt to the terrace ridge from the upper side; as the slope decreases more of the dirt can be moved from the lower side, and on gentle slopes it is customary to move dirt equally from both sides to the terrace ridge.

Crops grown and machinery used will also affect the required terrace cross section. Where row crops are grown and cultivated with one mule or one-row equipment and harvested by hand, as is cotton, a comparatively narrow terrace is satisfactory. A terrace with a base width of less than 15 feet is difficult to maintain at the required height. Where tractors are used it is very difficult to work on terraces unless they have a base width of 20 to 25 feet, even though the land slope is moderate. In sections where there is considerable small grain grown, which is planted with a drill of about 7-foot width and harvested with a binder, terraces with a 25-foot base width are satisfactory, although considerable difficulty will be encountered if the machinery is operated across terraces. Where machines of a large width of cut, such as the larger combines, are used, a base width of 30 to 35 feet is very desirable. Usually these very wide terraces are on gentle slopes, and the cost is frequently quite low when reduced to an acre basis.

CHANNEL CAPACITY REQUIRED IS LARGELY DETERMINED BY AMOUNT OF RUNOFF THAT MAY BE EXPECTED

The channel capacity required is largely determined by the amount of runoff that may be expected. Long graded terraces require a comparatively large channel in sections where rains of moderately high or high intensities for a period of thirty minutes to an hour occur. If the soil is dry and loose, or exceptionally permeable, rains of high intensity but of short duration will not cause the maximum rates of runoff.

The question of the most satisfactory grades and lengths for terraces is one that cannot be answered very definitely. At one extreme, we have conditions where by means of closed end level terraces it is possible to hold all of the runoff water in the terrace channel and cause it to go into the ground. Such conditions are present in parts of western Texas and western Oklahoma. In other sections, due to differences in soil and rainfall, such terraces are entirely impractical. In sections where the soil or subsoil is quite impermeable, some grade should be given the terrace. The grade that can be used without causing serious scouring of the terrace channel will depend upon the soil, type of vegetation, the cross section of the terrace channel, and the seasonal distribution of rainfall and runoff. If a large percentage of the runoff occurs during the period when no crop, or a cover crop is grown, a level terrace with open ends may be satisfactory even though there is considerable ponding. If such terraces are used one should expect occasional damage to crops in the terrace channels during the growing season. The smaller amount of runoff and soil loss from such a terrace may more than balance the occasional damage to the crop.

Very long graded terraces are not desirable as the concentration of water in the channel, as it nears the outlet, may cause scouring velocities and increase the size of the channel required. For level terraces with open ends, the probable amount of ponding increases with an increase in length, and the probability of one low place causing considerable damage increases. Level terraces with closed ends may be of any length. Fills across the channel occasionally will greatly reduce the possibility of losing a large amount of water due to a single low place in the terrace ridge and reduce the damage caused by such a low place if the terrace is overtopped.

With all of our terrace systems we have the problem of maintenance. Where the land is plowed once each year with a backfurrow on the terrace ridge and a deadfurrow in the terrace channel, very little other maintenance work will be required. It may be necessary to make fills at a few places on the terrace ridge or to remove some of the deposit from the terrace channel. Usually this work can be done efficiently with a slip or fresno. Where fields are listed but not plowed, it is not possible to maintain the terrace height without occasional maintenance the entire length of the terrace. Such maintenance work can be done efficiently with blade graders of any of the types generally used, or it can be done by plowing up the terrace ridge as a special farm operation in addition to the listing regularly used. How often this work will be required will depend upon the soil type, crops grown, machinery used, and the rainfall conditions since the terraces were last maintained. Cultivating or plowing across terraces reduces the height materially and greatly increases the terrace maintenance required. At the Tyler (Texas) station a two-way plow has been used in plowing terraced land, turning all furrows toward the terrace ridge and leaving the deadfurrow in the terrace channel. From a single season's observations this method of plowing seems to be quite effective in maintaining the terrace ridge and channel, and does not increase the cost of farm operations, except that a two-way plow is somewhat more expensive than the ordinary plow.

By using reasonable care in the cultivation of terraced land, well-built terraces can be maintained with a comparatively small outlay of labor and expense.

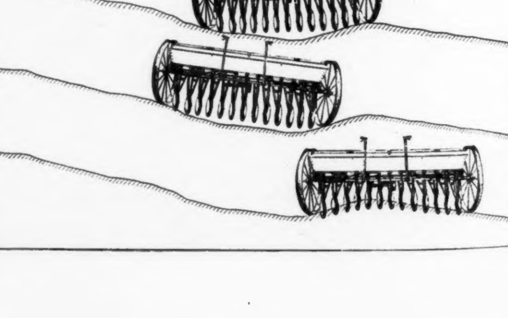
In the Corn Belt Area

By V. D. Young

IT IS the purpose of this discussion to present a few observations on machine problems encountered in terrace farming in the corn belt area and to point out a problem that exists in using two of the machines over terraced land.

Terracing was first introduced in this country in the South where the cropping plan was cotton following cotton,

Author: Soil Conservation Service, U. S. Department of Agriculture.

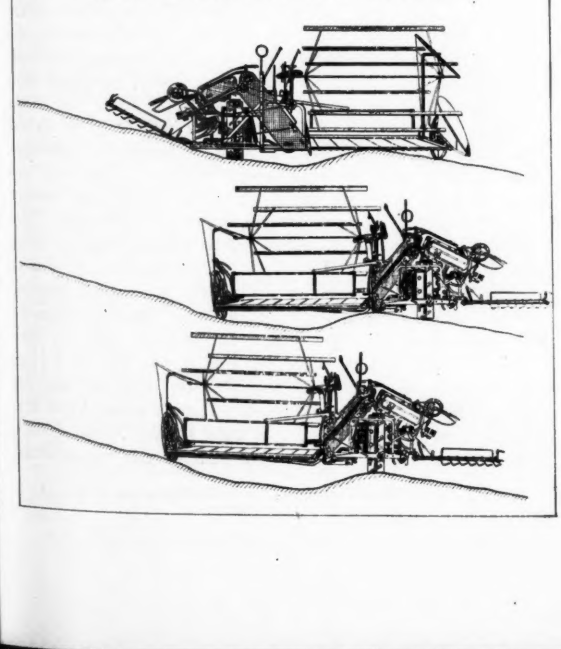


and the principal power unit was a negro and a mule. This small unit and a single-cropping plan was easily adapted to the man-made soil slopes. In using this same design of terrace in the corn belt, a number of problems are encountered. Instead of a single-cropping plan, a rotation of crops is used which requires several different machine operations. Terracing has also changed the location of field boundaries in many instances. Instead of the fields being laid out to conform to the slope of the land, they are usually laid out in a rectangular system conforming to section or farm boundary lines.

Terracing is not generally recommended on land having a slope greater than 12 per cent, because of the necessity of spacing the terraces close together, which also makes machinery operations more difficult, and also because of the added problem of economically conducting the runoff water from the top terrace outlet and the lower terraces to the bottom of the slope without severe gullying. In farming terraced areas to the best advantage, we find that it is best to do all the farming operations on the contour of the land or parallel with the terrace, to prevent soil loss, decrease cost of maintenance, and provide ample capacity in the drainage channel to prevent overtopping. Crossing the terrace ridge at right angles, or on a diagonal, with tillage machines has a tendency to tear down the ridge, thus decreasing its efficiency and increasing the cost of maintenance. The machines and machine sizes commonly used throughout the corn belt area are such that they often add to the difficulties of using them properly on the terraced land. It would seem that one of two things should be done, and that is either to change the design of the terrace so that the machines and machine sizes commonly used can be readily worked over the terraces, or else change the design of the machine so as to make it more flexible to operate successfully over the terrace embankments.

To change the design of the terraces so that our corn belt machines will work readily over them, involves a variety of problems. The terraces must be made broader, and the channels wider and shallower. The cost of constructing such a terrace on slopes on which nearly all of the soil, with the exception of one or two rounds, must be moved from the upper side, is considerably greater. The moving of more soil from the upper side also means exposing a less productive soil strata for many of our soil types. An alternative would be to shorten the length of the terrace and lower the height of the terrace embankment, or else seed the terrace channel and its side slopes to a permanent grass crop, thereby eliminating that portion of the terrace which causes the greatest difficulty. This latter practice might cause a difficult silting problem in the channel when the remainder of the terraced land is planted to row crops.

EIGHT FOOT GRAIN BINDER OPERATING OVER TERRACE PROFILES



The machine problem can be best shown by referring to the accompanying diagrams of two machines operating over an actual profile of a terrace at the soil erosion experiment station at Zanesville, Ohio. In this instance, the land has an average slope of 12 per cent.

In the case of the grain drill it will be noted that some of the disks cut too deep while others do not cut at all, and this part of the seeding amounts to broadcasting the seed. The machine shown is a standard 13-7 single-disk grain drill. If each individual shoe or disk had a greater range of vertical travel and a means of maintaining a uniform ground pressure, a higher percentage and a more uniform germination would result on these areas.

The diagram of the 8-foot grain binder shows this machine as it would operate over the terrace. It will be noticed how difficult it is to cut the terrace channel and the terrace ridge next to the channel, unless a backswath is taken in each terrace. This operation necessitates handling the tied grain twice after it is bound. Were the platform on this machine hinged, much like the platform on a hillside combine, most of the difficulty would be overcome.

The crop-producing power of many of our hill lands is limited by the moisture supply for the plant. It would seem that more work could be done to develop plows which would successfully throw the furrow slice up hill. This might be likened to a shingle roof on a barn. Plowing down hill lays the furrows much like shingles on a roof, thus sealing the soil against reservoir pockets. Were this plowing direction reversed, the condition would be like turning a shingle roof eave edge to the ridge, thus allowing the water a greater opportunity to percolate into this lower reservoir.

In soil erosion control work, we encourage the farm operator to leave as many of the natural drainage ways as possible in permanent grass where the land is not terraced but strip-cropped or otherwise kept in cultivation. Considerable thought should be given to means of quickly lifting and transporting tillage tools across these areas so as not to tear or otherwise destroy any permanent sod on these places. Once these drainage ways begin to cut, they soon become gullies which are difficult and expensive to reclaim.

In the Great Plains Area

By Raymond R. Drake

TERRACES and terrace construction are controlled probably more by the type and size of farm implements than by any other factor. The larger implements are more common on the moderate slopes and large fields, while the smaller units are more common on the greater slopes, rough broken areas, and small farms. This paper will have particular reference to the Great Plains region where wheat and sorghums are the principal crops, and the summer fallow tillage is frequently practiced to conserve the limited rainfall during the growing season.

The moderate rolling slopes of the Great Plains lend themselves well to large-size implements, broad-base ter-

Author: Associate agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. Assoc. Mem. ASAE.

races, and square and rectangular fields of 10 acres and up to the square sections of 640 acres.

Satisfactory terraces may be constructed with one-way disk plows, blade terraces, blade road graders, and elevating road graders. The efficiency of terrace construction on all slopes of 7 per cent or less increases as the size of equipment increases, and the maximum efficiency is reached when the elevating graders are used with sufficient tractor power. Greater efficiency is usually obtained with the large blade machines when used on slopes greater than 7 per cent as compared to the elevating graders.

On slopes of 5 per cent or less it is desirable to move an equal amount of soil to the terrace from each side; on slopes greater than 5 per cent, more soil should be moved from the upper side, and on slopes over 7 per cent, it may be desirable to move all the soil to the terrace from the upper side.

The grade of terraces must be such that water is removed from the field before damage to crops can occur; yet it must not be great enough to produce scour in the terrace channel. It appears from experiments at Hays that the terrace channel should be made level for a few hundred feet near its upper end, and then gradually increased to not more than 4 inches per 100 feet.

The terrace cross section should be determined by the farming method and crops anticipated for each proposed terraced field. If the land is to be farmed on the contour between terraces, a narrow base terrace may be used. If farmed in straight rows parallel to fence or road, a broad-base terrace on a moderate slope or a combination of the two methods may be used. A combination of the two methods, contour and straight-row farming, and the narrow and broad-base terrace are giving satisfactory results at the Hays (Kansas) station.

The terrace may be constructed to the proper width and height, or to the proper height and a narrower cross section than desired. The width may then be gradually increased by a few years of proper tillage. The inconvenience of the narrow-base terrace may be justified for a few years by the savings in construction costs. Moreover, less soil will be disturbed to cause a possible reduction in yield for the first few years.

TERRACE MAINTENANCE IS OF COURSE AN EXTRA COST WHEN IT IS IN ADDITION TO REGULAR FIELD TILLAGE

Terrace maintenance is an extra cost when it must be done in addition to the regular field tillage. Little maintenance, if any, will be required when growing wheat and sorghums, or summer fallow tillage, if the proper implements are used and a combination of the contour and straight-row farming may be used. The lister, ridge buster, light surface tools, and one-way disk plows are recommended for the proper tillage. The implements are available to the farm trade with the exception of a one-way disk plow that will plow in either direction. Listing in the general direction of terraces can be used only if it is equipped with a basin-forming attachment to prevent water from flowing down the furrows. The one-way disk plow should never cross a terrace and should plow the soil up the hill from the terrace channel. In this manner the one-way tillage will be able to maintain the terraces to the proper height and gradually increase the cross section.

SUMMARY

The basin-forming attachment and independent beam lister, the one-way disk plow plowing up the hill from the terrace channel to the terrace top have been used several years at Hays (Kansas) station with excellent results and no terrace maintenance has been necessary over a period of years, and no terrace maintenance is anticipated on slopes of less than 7 per cent in the future in growing wheat sorghums and summer fallow tillage. The two-day disk plow is not on the market, but it is expected that it will be soon.

In the Pacific Northwest Area

By P. C. McGrew

IN EASTERN Washington and Oregon and Western Idaho the farms are usually large. The single-bottom terracing plow and smallest size terracing machines are therefore not economical units to use with the power available. Many farmers use teams of 6 to 10 horses and for economical work terracing equipment should be adapted to such size teams. Terracing graders with blades from 6 to 9 feet in length would be about the right size in most cases. A large number of tractors are used, mostly of the track-laying type, the usual sizes being from 20 to 45 horsepower, the average being 30 or 35. With such power units a blade less than 8 feet in length does not furnish a load for the tractor and a longer blade is usually desirable.

Many of the slopes are 10 per cent or more; therefore, for best results practically all the soil should be moved from the upper side. All types of graders should be of such design that they can be easily and rapidly reversed at the end of the terrace. The elevating grader could not be used to best advantage, unless it could be reversed at the end of the terrace. Owing to the steepness of the slopes the machines should be designed so they are not likely to upset. This usually can be accomplished by a fairly wide spacing of the wheels, although the wheels must not project beyond the end of the blade when it is operating at the proper angle.

It is not necessary to provide as much channel capacity in eastern Washington and Oregon as in the southern and eastern states. The maximum rainfall intensity in the western area is less than half as much for all periods from 5 minutes up to 24 hours. This comparative data is shown in "Rainfall Intensity Frequency Data," USDA Miscellaneous Publication No. 204, by David L. Yarnell.

The practice of scraping off the topsoil to construct the terrace ridge, frequently leaving the subsoil exposed, has sometimes been criticized. In an attempt to overcome this objection, seven terraces were constructed on a slope of 8 to 14 per cent by moving about 4 inches of topsoil from a strip 30 feet wide, up the slope before starting the ridge. The ridge was then constructed by moving soil from the channel, and after the low places were built up with the fresno, the topsoil was moved back down the slope covering the channel and ridge to a depth of 4 inches. The work was done with a terracer having a nine-foot blade pulled with a track-laying tractor. The cost was three to four times as much as for a similar size terrace where the soil is moved directly to the terrace ridge. This additional cost would probably not be justified except under special circumstances. The field where these terraces were constructed is being used as a nursery. It is quite possible that the method used might be improved upon as considerable difficulty was experienced in moving the soil back down the slope. This difficulty was partly due to a large amount of stubble being mixed with the soil and also due to the difficulty of moving loose soil over other loose soil.

The practice of terracing is new in the Pacific Northwest, and it is to a large extent still in the experimental

Author: Agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. Mem. ASAE.

THIS OUTFIT IS INTENDED TO MEET THE DEMAND FOR LOW TERRACING COSTS. IT IS DESIGNED AS A ONE-MAN OUTFIT WHICH CAN BE OPERATED WITH A GENERAL-PURPOSE FARM TRACTOR. IT IS CLAIMED THAT THE POWER REQUIREMENT IS LOW IN PROPORTION TO THE DIRT MOVED

stage. This section has power suitable for pulling terracing machines of practically all types. Large power units require large tillage, planting, and cultivating implements. It is more difficult to operate these large units on terraced land, which difficulty must be overcome before terraces are entirely successful. By building wide terraces, the large machinery can operate quite successfully on slopes up to about 10 per cent, while on the steeper land modifications of tillage practices would be necessary.

Factors Affecting Terracing Costs

By G. F. Hoover

THE ACCEPTANCE of terracing by the farmer and the general public, the determination of the land that should be terraced, and the land which is terraced—in fact, the entire soil conservation program—is an economic one. If it is to succeed and become permanent, it will have to be justified from this angle. Farmers will not continue the program, if it cannot be carried on at a cost low enough to justify that expenditure on the land.

It seems only logical that, if terracing becomes an accepted practice in good farm management on sloping land, and the large area of land in the United States that should be terraced is actually terraced, some method will be accepted whereby certain proportions of the cost will be borne by those who directly receive the benefits therefrom. Those of us who have been in extension work know that, if our recommendations are to be accepted, we have to give very specific information, not only as to how it should be done, but as to what it will cost and what will be the ultimate value of the work after it is done.

Assuming that the farmer is expected to bear the expense or to contribute towards the expense of terracing, one of his first questions is, "What will it cost?" The answer to this is not found in books, nor can it be given until after his farm has been carefully surveyed and a reasonably accurate estimate of the lineal feet of terrace and the amount of outlet work has been made. Then a cost figure must be estimated. The farmer or landowner wants this information on an acre basis—not in cost per mile or cost per cubic yard of dirt moved. The nature of terracing work has led naturally to the expression of cost on a per mile, per rod, or per lineal foot basis, which has little or no meaning to the average layman or landowner. In reality it has very little significance even to the skilled agricultural engineer, unless he has more information than is usually given or available.

For cost data to have any practical meaning, even to the skilled agricultural engineer, it is necessary to have complete information relative to the job, in order to evaluate the several variable factors which constitute the various elements of the total cost. Unfortunately, much of the cost data that is available is misleading—misleading in that it presents only a part of the picture, and in that it does not extend over a sufficient quantity of work to make it a fair average; and the one who presents it will frequently select outstanding performances and neglect to give the proper qualifications. Any cost data is incomplete unless a cross section of the terrace is given. Terracing is primarily a dirt-moving operation, and if the cost were expressed in terms of cubic feet of dirt per lineal foot or rod, it would have more value and meaning for comparative purposes. Contractors are universally paid for the dirt moved by cross-sectioning the excavated borrow pit. The one exception to this is on the Mississippi levee, where the contractors are paid for 75 per cent of the dirt in the levee where it is cast in. It would seem only logical that this type of data on terrace construction should similarly be subject to some standard rule.

Some of the factors that must be considered in arriving at a definite cost per acre for terracing are:

1 The field or area terraced, including lineal feet of terrace necessary, the slope in per cent, soil type (surface and subsoil), vegetative cover, number of gullies to be crossed, and weather
2 The terrace built, including cross-section (height, width, and average distance dirt is moved laterally), and length
3 The equipment, including size and make, condition, and skill of operators
4 Cost of equipment and operating cost, including fuel consumption, oil consumption, grease used, depreciation, repairs and maintenance, interest on investment, and labor cost (operators)
5 Cost of engineering and supervision

Author: Engineer, Cleveland Tractor Co.

6 Cost of fresno or other work to bring low spots up to grade
7 Outlet cost.

It will not be practical or feasible, in many cases, to elaborate on each of the points that influence the actual and complete costs. On the other hand, it is vital in making a comparative study of costs with the same or different equipment and in the same or different localities to know what items were counted in, and to have information on most if not all of the points listed.

Problems in Determining Terracing Costs

By W. A. Clegg

THIS MATTER of terracing costs is one in which we find so many variables that it is difficult to arrive at a definite estimate. The cost of terracing will vary with soil types and conditions. The topography or slope of the ground also has an effect, inasmuch as on steep land we need more terraces per acre to control erosion than on the gentler slopes. The number of gullies and their size have an effect on the cost of terracing. The cheapest terraces are those built on gently sloping land, say $2\frac{1}{2}$ to 4 feet per 100 feet, which has not yet eroded sufficiently to cause gullying. This has been given as an additional reason for early terracing of land. In the first place, by terracing land before it is entirely washed away, the original fertility is saved, and, in the second place, terracing can be done much more cheaply.

Numbers of methods of arriving at terracing costs have been tried. The first contract work in terracing was done on a per acre basis. This method however, was found to be so unreliable that, in order to protect himself, the contractor had to make an unreasonable charge on the greater part of the land. Largely for this reason, present terracing is done on the per hour basis, the terracing outfit being charged for on the basis of so much per hour for each hour's work done on a man's farm, with any given size of equipment. In this way the charge for the equipment will be considered reasonable and the farmer gets the benefit of easily terraced land.

In talking with a farmer, however, particularly in sections of the country in which they are not familiar with terracing, it becomes necessary to reduce the charge to an acreage basis, as the farmer thinks in terms of acres. In doing this, we can estimate the cost per mile of terraces, and, by knowing the average number of average acres per mile in the different sections of the country and the type of terrace required for that section, a rough estimate of what it will cost per acre can be given the farmer.

From the summary of a tractor-terracer survey made by our company, we find that the number of hours necessary to build terraces varies in different sections of the country from 7.46 hours in the southern section to 18.83 hours in the central section. From this, using the rental charge of the equipment in use, the cost per mile can be figured. The number of acres per mile of terrace varies from 10.36 acres average for the southern section to 18.9 acres per mile in the Kansas-Nebraska section. These estimates are subject to variation within the sections themselves. For instance, in the South, which shows an average acreage per mile of 10.36, we know that the acreage actually varies from $7\frac{1}{2}$ to 15. It is a matter of taking into consideration the slope of the individual field, or, in terms of a community in general, the average slope of the land in that community.

Author: Agricultural engineer, Caterpillar Tractor Co. Assoc. Mem. ASAE.

We made some attempt to arrive at a rule by which miles of terrace could be reduced to acres. This was abandoned, however, due to the large number of variables encountered.

Another factor which must be taken into consideration is the size of terrace. We find terraces varying in size in different sections of the country, due largely, we think, to the size of the farming equipment. Terraces are smaller in the eastern section of the country—say 12 to 18 ft wide—and gradually increase in size as we go west to terraces in the wheat section of 40 to 50 ft wide.

As we get further into terracing work, we find it almost impossible to estimate the cost of a completed terrace system without looking over individual farms and taking into consideration the variables that appear on those farms.

In making comparative costs of constructing terraces with different kinds of equipment, we must first know that the terraces are going to be equal when completed. Furthermore, we must know whether the cost includes merely the ridge, whether low places have been filled, whether outlets have been built, and what kind of outlets were used. Too many comparisons have been made on the basis of the cost of the terrace ridge, without taking into consideration how much more work must be added to make a completed job.

Then, too, consideration in some cases must be given to tearing down old terraces, pulling stumps from terrace lines, and filling gullies preparatory to building terraces. All the factors involved in terracing, together with the ability of any given type of equipment to take care of these variables, will affect the total cost.

IT IS USUALLY RECOMMENDED THAT FIRST TERRACING BE DONE ON BEST LAND NEEDING TERRACES

All agencies working on terracing recommend that the first work be done on the best land needing terraces. We have found, however, that in most cases where a terracing program has been started, the first work done is on fields that have been abandoned on account of gully formation resulting from erosion. This kind of work is generally termed "reclamation". Cost of reclaiming land is very much greater than cost of terracing land. The reason that reclaiming the land is the first work done, is probably because the need for saving the soil on badly eroded fields is so evident.

Too many times two sets of cost figures are compared, where one set represents the cost of terracing a good field, and the other set of cost figures represents the cost of reclaiming an abandoned field in addition to terracing the land. Without a photograph of the field before and after terracing to study at the same time you are studying cost figures, it is almost impossible to arrive at a fair comparison of cost in the two cases.

In the greater part of the United States the function of a terrace is drainage; but there are sections where the function of a terrace is to hold all water that falls on the field. The cost of construction of these two types of terraces will vary as much as 100 per cent. The drainage type terrace calls for the construction of outlets, which will increase its cost. The level, closed end must have more capacity to hold the water that falls. Therefore, the purpose of a terrace will affect its size, which also has considerable bearing on the cost.

The size of the field, the topography of the land, the size and capacity of the terrace, are factors that affect the size of equipment that can economically be used in terrace construction. Also, the number of acres to be terraced in any one community, which affects the hours of use per year, is a factor in considering the size of equipment to use. Taking one factor at a time, the size of equipment has a

very definite bearing on the cost, regardless of whether gasoline or Diesel tractors are used.

The experience of commercial organizations has been that 1000 acres or more of terracing per year must be available to justify the use of large terracing equipment. In areas where terracing was generally accepted it was first thought that this amount of terracing would pay for a Diesel outfit, say, within two years. However, it will probably require five years of experience to determine just what number of years is necessary to pay for the equipment.

There are areas where terracing is not generally accepted. In such sections where only 200 to 400 acres can be organized in any one community, the smaller tractor of the spark-ignition type, with terracer to match, selling for approximately $1700.00, will build terraces economically. The cost of building terraces with this equipment is approximately 50 per cent greater than with a Diesel-powered outfit.

As regards the commercial side of the soil conservation movement, it can be said that commercial organizations will have to learn to exercise considerable patience in their sales promotion activities, and not expect results too quickly. Field organizations to develop sales of terracing equipment should not be built up too rapidly, nor should sales programs be pushed faster than the communities have the ability to absorb them. Every outfit that is delivered should be carefully watched and fostered until it is practically certain that the terracing movement is accepted in the community and that there are several local tractor and terracer operators who can make the equipment function properly. Unless these two all-important factors are present in every case, there is no certainty that the outfit will stay sold. Failure to do the necessary thorough groundwork and lack of follow-up will account for 99 per cent of the failures and repossessions that have taken place to date.

Types of Machines and Selling Policies

By J. W. Carpenter, Jr.

I WOULD like to emphasize Mr. Baird's statement that the cross section of a terrace must necessarily be varied to suit cultivation practices, type and intensity of rainfall, and soil types, and also to point out that the acreage protected per mile of terrace is, as a rule, smaller in the eastern sections of the country where the smaller types of terraces are built, than in the western sections where, due to cultivation practices and rainfall characteristics, larger terraces are necessary, thus keeping the per acre cost more or less uniform in all sections of the country.

For the past several years I personally have been more interested in ways and means of getting the job done, which has meant the use of various types and sizes of machinery. I wish to elaborate, therefore, on Mr. Baird's statements in regard to blade graders and fresnoes.

Two-Wheeled Terracers. All of the especially developed blade terracers are two-wheeled machines. Why? The two-wheeled terracer which attaches directly to the tractor by some form of gooseneck hitch, is much lower in first cost and builds terraces more economically, in that it has better penetration, saves a large percentage of the turning time over that of the four-wheeled grader, and can complete the terrace ridge much closer to the ends.

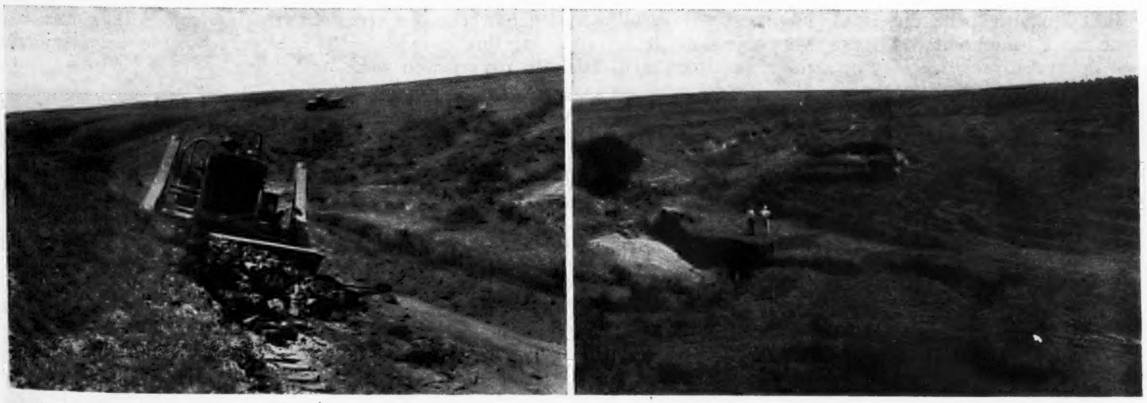
Then, too, fills across low places are an important part of terrace construction costs. By proper manipulations an even greater percentage of these fills may be made during construction with the two-wheeled terracer than with the four-wheeled grader, and, in addition, the two-wheeled outfit may be used in place of a bulldozer or fresno for limited fills. With a well-trained tractor driver the two-wheeled outfit can be handled as accurately on the terrace ridge as can the four-wheel grader. It is a recognized fact that experienced operators of four-wheeled graders prefer the four-wheel outfit until they have learned to operate the two-wheel outfit, after which they usually prefer the latter.

An additional advantage of the two-wheeled outfit which is especially valuable when building terraces largely from one side, is the ease with which it may be reversed. A terracing machine should also be provided with an effective method for shifting the blade and circle to the side.

Size of Outfit. As Mr. Baird points out, there will always be a place for the smaller terracing machine, for use where the farmer wishes to build his own terraces with the power available on the farm. Due to the large amount of labor required, however, the tendency is definitely toward the use of the larger units especially where they are available on a rental basis. On the Mississippi SCS project, at Meridian, Mississippi, terraces built with teams and fresnoes at a reasonable rental for teams and labor cost better than $150.00 a mile, as compared with terraces built with a 9-foot blade at $34.50 a mile.

The size of equipment will have a definite bearing on terracing costs. With the larger equipment, the cost per mile decreases.

Author: Agricultural engineer, Caterpillar Tractor Co. Mem. ASAE.



TWO VIEWS OF A "REPAIR" OPERATION ON THE SOIL. FILLING GULLIES NEAR ALBION, NEBRASKA, WITH THE AID OF A TRACTOR-MOUNTED, HYDRAULICALLY-OPERATED BULLDOZER. BY THIS METHOD GULLIES ARE FILLED WITHOUT THE DELAY REQUIRED WHEN SOIL-SAVING DAMS ARE EMPLOYED. TERRACES MAY BE IMMEDIATELY CONSTRUCTED

In some sections of the country, particularly where terracing is new, it has been difficult to put the larger units across. Development of terracing equipment over a period of time has been from the small to the large.

In the South where terracing has possibly received its greatest development to date, terraces were at first constructed with a homemade drag. Terrace construction moved by stages from this start to that of the steel V-drag, the small blade terracer, the 8-foot blade terracer, and then to the larger machines. We know now that terraces can be more economically constructed with the larger machine, the 40-horsepower tractor and the terracer with a 10-foot blade being recommended for the smaller fields and the 50-horsepower tractor and a 12-foot blade machine being recommended for the larger fields in which terraces of 1,000 feet or longer are encountered.

We believe, however, that in sections of the country where terracing is new, it will be an error to overlook the use of small equipment. This smaller machinery has a lower first cost and will build good terraces. Farmers in sections where terracing is little known often hesitate to put $4000.00 to $5000.00 into a terracing outfit, when it would be easy to sell them a $1700.00 outfit. The larger outfits will follow.

The practice of placing terracing units in a community to be rented to farmers for terracing on an hourly basis is increasing. This practice in itself is sound; however, there are grave dangers in its application. In the first place, an efficient organization must be behind the use of the tractor; in the second, the hourly rental charge must be high enough. This charge when made to retire the cost of an outfit purchased from an implement company, should be large enough to allow for the retirement of the purchase price of the tractor in not more than three years, which will allow for a percentage down payment to be retired the third year and the balance of the purchase price of the tractor to be retired during the first two years of operation.

This suggestion is based on sad experience. Our company has found that in order to make the deal sound, sufficient cash interest must be maintained in the outfit by the purchasing agency to make it more profitable for them to keep the outfit than to have it repossessed. Out of all our deals in which this cash interest was maintained, only one-half of one per cent of them went sour. In all the deals where this cash interest was not maintained, 96 per cent of them have gone sour. It is felt that the implement companies have done their share toward the promotion of the sale of equipment to terracing associations or other cooperative agencies. They have been left to hold the bag in a sufficient number of instances. We shall continue to do everything possible toward the promotion of the erosion control program. However, in the future any sale of equipment must be made on a strictly business basis. Erosion control is either worth what it costs or it is not. If it is worth what it costs, the sooner we get it on a business basis, the better off we will all be. If it is not worth what it costs, let's forget the whole program right now.

What America's Soil Conservation Program Requires of the Engineer

(Continued from page 46)

contemplated terracing. Because of the size of the field and its topography, one of the outlets could have very easily taken care of the terrace system. The engineer in charge of the work constructed two outlets, one on each side of the field. This not only involved additional construction and upkeep costs, but also caused the farmer considerable difficulty at the turns in order not to disturb the sodded outlets.

In contrast to this example, where the general farming practices were not taken into consideration, is a more recently completed piece of work where the engineer used good judgment by straightening the terraces where possible, controlling the outlet with vegetation as far as was feasible, and using permanent structures where they were the only solution. As first staked out, the terraces had numerous short kinks in them, due to the engineer having followed the exact contour of the slope. This objectionable feature of the system was remedied by making numerous small fills across the draws. The change gave the terraces gradual curves that could be more easily followed with farm machinery. The single-terrace outlet was placed along a fence row so as to give very little trouble in the operation of field machinery. The upper part of the outlet location had a rather gradual slope that could be sustained easily by vegetation. The steeper lower portion had been severely gullied. Therefore, the upper part of the terrace outlet receiving water from three of the upper terraces was constructed as a vegetative outlet. In the badly gullied lower portion several permanent notch spillways were constructed, giving due regard to the amount of water which they would be required to handle.

In addition to a knowledge of the individual farm plans, the engineer must have a knowledge of the growth characteristics of the crops to be used in order to plan a suitable time to do the engineering work. This is particularly true of terracing, which should be done while the ground is without a crop. Knowledge of methods of cultivation and machinery used for production of the crops to be raised is also vitally important in the designing and construction of terraces. Although contour and strip farming are essentially agronomic methods of control, it is important that the engineer undertaking a control program understand the place and value of each. He should be able to stake out fields for contour and strip farming and assist the farmer in putting such a program into effect.

A knowledge of hydraulics, concrete work, and designing is just as important as a knowledge of agriculture, and it has been our experience that agricultural engineers lacking this knowledge have sometimes made serious mistakes in construction work.

We appreciate that agricultural engineers doing soil conservation work cannot specialize in all phases of agriculture. However, with a knowledge of the fundamentals of agricultural economics, soils, crops, engineering, etc., they would appreciate the necessity for securing complete and reliable information concerning all factors which would contribute to the success or failure of the engineering work contemplated.

The purpose of agricultural engineering work in a soil conservation program is, from the farmer's standpoint, to stabilize and preserve the soil for crop production purposes. The agricultural engineer in soil conservation work must, above everything else, be a man of vision with an open mind who is able and willing to grasp new ideas and apply them in a practical manner to the problems at hand.


FIG. 1 (LEFT) THIS PICTURE SHOWS THE TYPE OF TERRACE CONSTRUCTED ON THE DADEVILLE (ALABAMA) PROJECT, AND THE SMALLER OUTFIT (48 HP) USED IN THE TESTS. FIG. 2 (RIGHT) THE LARGE EXPERIMENTAL TERRACER AND 76-HP TRACTOR USED IN THE TEST

The Size of Terracing Equipment

By N. W. Wilson and M. L. Nichols

IN A RECENT PAPER setting forth the requirements for terracing equipment, it was pointed out that it would be necessary to construct terraces with fewer rounds to increase efficiency or lower cost by the use of larger units of blade equipment. Since the publication of that paper (AGRICULTURAL ENGINEERING, March 1935, vol. 16, no. 3, pp. 93-96), a larger outfit with sufficient power and capacity to reduce materially the number of "throughs" has been built by one of the leading manufacturers of power equipment and tried out in comparison with a standard-size machine built by the same manufacturer. The tests of these machines were conducted cooperatively by the engineers of the Alabama Agricultural Experiment Station, the Soil Conservation Service, and the manufacturers. The results obtained are being presented here in response to the very general inquiry by manufacturers and farmers as to the most economical size of power terracing unit.

The tests of this equipment were made on rather typical Piedmont farms. The general topography was rolling, with grades averaging from 7 to 12 per cent. The fields were in old bench terraces ranging in height from one to six feet, the bench terraces containing large rocks and frequently stumps and saplings. The soil was Cecil clay, mainly B and C horizons, most of the surface having been washed away. In general, the conditions were as severe as one would expect to encounter in practical terracing.

The small outfit was operated by student engineers, and the large outfit by an experienced road grader operator. None of the operators were experienced in terrace construction.

The terraces constructed were of the broad-base ditch type, a section of which is shown in Fig. 1. These were built entirely from the upper side according to the method previously described in AGRICULTURAL ENGINEERING for March 1935 (vol. 16, no. 3). The laying out of terraces, checking, and keeping of records was done as part of the regular field work in terracing by the Soil Conservation Service staff on Project No. 18 in the Dadeville area.

Both outfits were similar in design and construction. The smaller of these units consisted of a 48-hp track-laying tractor designed to burn fuel oil, similar to that used in Diesel tractors, by solid injection. The larger outfit was of the identical type, but had a 76-hp rating. The smaller was of the hill-side or wide-tread type, and the larger was a standard tread.

The terracers, while of the same general type of construction, differed in that the larger outfit (Fig. 2) had a 12-foot blade which was power controlled and operated, the power being supplied by an auxiliary gasoline engine mounted on its frame.

Both of these terracing machines were experimental models, having been built from standard road grader designs. The leaning wheel, tilting frame, and axle shift features of the road grader were retained on the large outfit. The wheel base on the large grader was the same as that used on the standard road machine, which was approximately 9 feet. All these road grader features were used in the tests where desirable.

The small terracer was a standard, hand-operated model, equipped with a 10-foot blade. On this model, as well as on the large one, an auxiliary blade-shift attachment, such as is common on road machines, was used to increase the side shift in tearing down old terraces.

The working conditions under which those machines were tested were essentially those of the regular terracing work being conducted in the project area. In most cases the machines worked in the same field, building alternate terraces as they came to them. The average length of the terraces was 900 feet. The use of the smaller outfit was continued for training purposes for some time after the tests with the larger outfit were discontinued, which accounts for the larger area on which records were kept. Fuel lubrication oil and gasoline were measured each day as the terracers were serviced.

Cross sections of the terraces were made at the completion of the work in each field, at a sufficient number of stations to estimate the yardage of dirt moved with what was considered a reasonable degree of accuracy. The lengths of all the terraces were measured by pacing; the grades of completed terraces were measured with terraced lands; and the areas were obtained from aerial photographs.

Results of the tests are set forth in the accompanying table. It will be noted that a very considerable portion of the work consisted of tearing down terraces. While it is true that the conditions in each bench terrace were different, in that they contained various sizes of trees and bushes and

---

Presented before the Power and Machinery Division of the American Society of Agricultural Engineers at Athens, Georgia, June 20, 1935.

Authors: Respectively, agricultural engineer, Project No. 18 (Dadeville, Ala.), Soil Conservation Service, U. S. Department of Agriculture (Assoc. Mem. ASAE), and agricultural engineer, Alabama Agricultural Experiment Station (Mem. ASAE).

various sizes of rocks, it will be noted in the table that there was little variation in the number of feet of terraces torn down by the two outfits. However, the larger of the outfits required only two-thirds of the time required by the smaller outfit due to its being better adapted to this purpose.

The labor costs in the tests were based on rates of pay of the operators of the Soil Conservation Service. It must be assumed that operators of the same skill would be required by both outfits. The hours of operation were those actually devoted to the construction of terraces and do not include time lost for repairs, service, or adjustment of these experimental models.

In constructing these terraces, seven to nine "throughs" were required with the small outfit, and only three to four "throughs" with the large outfit. It was found that, while in many cases the terraces could be satisfactorily constructed with three throughs, generally, though, it was more economical to make four throughs so as to get a uniform structure throughout.

A few special tests were made of the rate of building with the large outfit in an attempt to ascertain what could be done under the rather rough conditions of the area. It was found that as much as 2,000 feet per hour could be built by this outfit.

It was concluded, from these experiments, that where large areas were to be terraced the large outfit, even at twice the initial cost, would be at least equally as efficient as the small unit. It would, moreover, have the advantage of requiring one-half the labor which would thus bring down the cost per acre. It would also have the advantage of being able to move larger rocks and stumps than the small outfit, due to its greater power. The larger blade appeared to handle the soil as efficiently as the smaller blades, and the amount of soil moved appeared to be in proportion to the power rather than the length of the blade. There was no appreciable difference in turning at the ends. This was due largely to the power control of the outfit which could be operated when moving on the turns. The shorter outfit, however, could get closer to the fence.

Obviously, the large outfit, in case of breakdowns, would present the disadvantage of tieing up more money, and more work would be lost while the machine is standing idle or being transported from field to field.

In general, it is concluded that this large equipment would have a real place under many conditions. From a few experiments on the flatter slopes, the efficiency appeared to be in excess of what was indicated by the tests on the steep, heavy clays. A few tests showed that on the sandy soils a very satisfactory terrace could be constructed with three throughs.

COST FIGURES OF OPERATION OF TRACTORS AND TERRACERS

	Standard size terracer and tractor (48-hp)		Power-operated terracer and tractor (76-hp)	
	Quantity	Cost	Quantity	Cost
Estimated cost of outfit		$4,000.00		$8,000.00
Number of hours operated	88.5		30.0	
Number of hours on road	2.0		2.5	
Number of hours working	86.5		27.5	
Feet of terraces built	55,300		33,950	
Number of hours building	74		20	
Number of feet built per hour	747		1,698	
Number of hours per mile built	7.07		3.11	
Cubic yards of earth per mile	997		1,036	
Feet of terraces torn down	11,900		11,000	
Number of hours tearing down	12.5		7.5	
Number of feet torn down per hour	952		1,467	
Number of hours per mile torn down	5.55		3.60	
Cubic yards earth moved tearing down	1,190		1,100	
Operating Costs:				
Gallons fuel oil at 9½c	230	21.85	140	13.30
Gallons gasoline at 12½c	2	.25	27.5*	3.44
Quarts oil at 4½c	35	1.58	22	.99
Pounds grease at 11c	43	4.73	18	1.98
Total operating costs		28.41		19.71
Operating costs per hour		.321		.657
Depreciation (10,000-hr basis)		.40		.80
Labor for operation at 40c hr		.80		.80
Total direct cost per hour		1.521		2.257
Cost per 100 feet building		.204		.133
Cost per mile building		10.74		7.02
Cost per cubic yard earth moved tearing down bench terraces		.0159		.0155
Cost per cubic yard building		.0108		.0066
Acres terraced**	105		49	

*25 gallons of gasoline used by terracing motor.
**Average of 7¼ acres per mile of terrace.

Discussion by H. W. Lindsay

WE ARE MET to discuss a modern phase of that age-old fight to counteract the effects of the forces of nature upon the works of man. This modern phase with which we are concerned assumes proportions of greatest significance, because it is related to our ability to continuously provide the very fundamentals of our existence, food and clothing. It is therefore fitting that our consideration of the many factors involved in the subject should be attended upon by all of the facilities which these advanced times have placed at our disposal.

It has been man's constant work to move portions of the earth's surface into position for his advantage in the struggle for existence, and it is, therefore, natural that many devices for this purpose should have been put into use as his ingenuity gradually provided better and better means of exerting greater and greater force toward this end. It is further natural that these devices should follow one another in a more or less routine order, inasmuch as it seems to be normal that our mental processes follow in more or less routine order from one impulse to the next.

With the advantage of experience gained in working out problems of similar nature in other fields, there is sound reasoning to cause the active enlistment of industry in this greater battle to conserve our tillable soil. Tribute must be paid to those great leaders of agriculture who have, by persistent and consistent study and experiment, evolved methods of soil erosion control which are adaptable to the use of tractor power.

As we work our way into this broad application of tractor power toward the protection of our farm soil from the effects of running water, we are naturally influenced by our experiences in applying tractor power to the improvement of our means of transportation, through the use of road graders to shape our highway surfaces and drainage ditches.

We may review with interest the development of the road grader from a wagon with a blade mounted underneath to the present power-operated machine which is capable of adjusting its working edge and surface into a wide range of operating positions to handle the work, not only of shaping the roadway surface and ditches, but also to reach out and shape the bank slopes beyond the ditches. The development of this

Author: In charge of grader department, Allis-Chalmers Manufacturing Company.

machine went forward very slowly at first but gained impetus for the pressing demands of the automobile and the advantage of adequate tractor power.

At present, terracing gains by this development in the road grader field, a type of machine which is able to not only form the present terrace cross sections, but may be made to possess the added ability to quickly tear down old bench terraces. It is not to be thought of at this time that the machines which are available will be the ultimate answers to the problem of tractor power application in this field. It is better to believe that time should not be lost in carrying on the advantage of our present position into a breadth of effort in this field which will encourage the activity of those forces which always seem to provide the means to the desired end.

There are many factors which must affect the course of this development. Placed in the classification of a farm tool for individual use, the terracer becomes a very simple and, of necessity, an inexpensive piece of equipment. Stimulated by the necessity of quick action and supported by the foundation of ample financing, the demand would shift attention to the large, rugged type of machine, capable of working in conjunction with even a very powerful size of crawler-type tractor. It seems self-evident that the varying needs of a country, having the diversity of soils and topography which our country has, would always require the development of several machines varying at least in size and most likely in operating characteristics.

Balanced against the necessity of features which must add cost to provide strength and extreme maneuverability, we must strive for high productive capacity to attain that most necessary of abilities—low operating cost. Truly there is a challenge to industry to bring with its enlistment in this work the best that it possesses in facilities and experience.

FUNCTION OF AGRICULTURAL ENGINEERS IN TERRACING MACHINE DEVELOPMENT

The stimulus of demand is already at work through the efforts of those wise governmental agencies which have demonstrated to the farmers the practical application of the methods of control mentioned above. The need for action in industry will follow the orderly application of the forces which must be arranged and directed toward the organization of a program which will be the most important step in agriculture ever attempted.

It is logical to assume that the demands of this program upon industry will be transmitted largely through the efforts of agricultural engineers in their work of soil conservation and it might, therefore, be beneficial to point out here some of the difficulties which are attendant upon the process of placing a machine, such as a terracer, into the field.

You are probably aware that a manufacturing organization, such as would build a terracing machine, is as much interested in the cost of manufacturing the machine as you are in the cost of its use. A cost sufficiently low to permit the marketing of the machine can be attained only by the use of modern tools, some of which are very expensive. In this case, the word "tools" includes a wide variety of shop devices including dies for shaping bent metal parts and forming parts which are forged, fixtures which hold parts in proper relation to other parts and jigs which locate accurately the machine processes, and a multitude of items which are all dependent upon the design of the machine.

It is, therefore, very important that the design of the machine be as nearly correct as possible before it enters production. In this case, the design of the machine must be based upon the job requirements outlined to the machine designing engineer by the engineer who is to dictate the use of the machine in the field. The importance of close cooperation between these two engineers is evident and is reflected in the ultimate cost of the machine. Changes required by the field engineer sometimes effect parts involving expensive tooling and serious delays.

It is therefore, of great importance that those in charge of carrying out the work involving the use of a machine in the development stages should determine as accurately as possible the operating characteristics required of the machine, in order that its design may include those features which are necessary to make it perform the functions expected of it. Continuous friendly contact between the user and the manufacturer is certainly the quickest means possible to obtain the much desired low cost. The proof of any machine is found in its use, and it would seem that the development of a terracer should be particularly benefitted by the fact that the field contact of agricultural engineers, who receive considerable mechanical training, would be of great assistance to the designing engineers.

Discussion by John S. Glass

I REFUSE TO CONSIDER that the control of erosion, by one means or another, is the individual landowner's responsibility. The equipment that will be discussed here briefly does not fit a "one-man job," but does accomplish results economically when handled on a cooperative scale.

Seventeen years of holding terracing demonstrations under all kinds of adverse circumstances led to a definite desire to really get the job done. And after more than a year as chief engineer of the Kansas soil conservation area, the following equipment is found to really accomplish the completed terrace construction at a low cost.

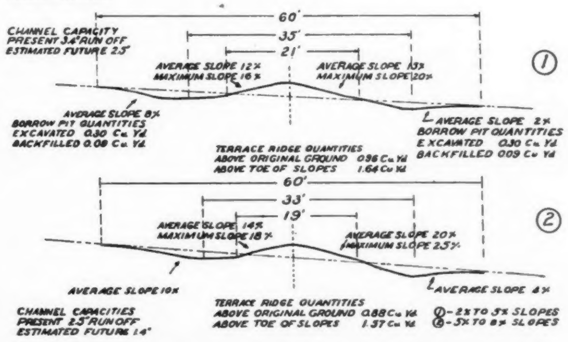
Time does not permit lengthy discussion of these various units. (I will glady furnish more complete discussion to those who are interested.)

We believe in large terraces. Unless approximately one yard of earth is *moved* into the terrace ridge per foot of length, we are of the opinion we have only a "sweet potato ridge."

The following constitutes the equipment necessary for a complete terrace-building unit:

1 The first in importance among the equipment units is the 75-hp Diesel tractor. This size tractor will handle the 48-inch elevating grader under all field conditions. This elevator is equipped with a 32-inch disk plow and 10-foot carrier.

Author: Extension agricultural engineer, Kansas State College. Mem. ASAE.



STANDARD CROSS SECTIONS ADOPTED IN THE KANSAS AREA OF THE SOIL CONSERVATION SERVICE FOR NEW UNSETTLED TERRACES ON 2 TO 5 PER CENT SLOPES AND ON 5 TO 8 PER CENT SLOPES

2 Two 50-hp Diesel tractors, wide tread, to reduce excessive wear on brakes and steering clutches.

3 Two 12 or 14-foot blade graders.

4 Two 2-yard rotary fresnos for making fills.

5 Road ripper, 8 to 10-foot tread, for straightening terrace lines and tearing earth loose for fresno fills.

6 One tandem disk, 3-section—two cut and cover, one trailer disk.

7 Service truck and supply of repairs.

The first machine operation is that of plowing out the stake line along which the terraces are built. This job may be accomplished in a very satisfactory manner by using a single-bottom lister. This is an important job; it must be done accurately and rapidly.

The ripper comes into the field. This tool is of standard road machine design. We use it to cheapen the cost of moving earth with the equipment to follow, particularly the rotary scrapers with which fills along the terrace lines are built and the blade grader in outlet construction. This tool also is being used to loosen the earth for terrace construction with a blade grader. It has permitted us to increase the height of the moldboard 50 per cent and permitted the development of the blade grader into a loose-earth-moving machine, which will have its effect in the development of a cheaper blade terrace of large cross section.

Outlet construction is the first step in our procedure. This is largely a blade operation, but is speeded up materially in most instances by ripping the channel prior to the blade work.

TERRACE SURVEY ENGINEERS ENDEAVOR TO ELIMINATE CROOKS AND SHARP BENDS IN TERRACE LINES

Our terrace survey engineers avail themselves of every opportunity to eliminate crooks and sharp bends in terrace lines. This calls for cuts and fills to be made along terrace lines where ordinary procedure is to follow strictly the contour of the land. The use of the ripper makes it possible to accomplish this desirable portion of the terrace-building operation in the most satisfactory manner. Earth material removed in a cut is used to make the adjacent nearby fill. Moving earth for these fills longitudinally along the terrace line makes it possible to build these fills *without borrowing top soil from over the intervening space between terraces,* a very desirable feature in terrace construction from the standpoint of crop production immediately following the installation of a system of terraces. We consider the ripper, as we are using it with a 50-hp Diesel tractor, the most logical solution to our difficulties in handling particularly tough soil conditions, a most valuable addition to our list of field equipment. We believe this is the first time this tool has been given a place on the terracing-equipment program.

Upon the completion of the ripper job on the outlet channels, these artificial water courses are excavated and shaped accurately, using a 12 or 14-foot grader drawn by a 50-hp Diesel tractor.

While we have been engaged in the outlet channel, other things of interest have been going on in this field. A 75-hp Diesel tractor has come onto the job pulling a machine that had not been seen at the erosion control job prior to our adoption of it on the Kansas area. Here is the elevating grader. This is really an economical earth-moving machine. We have moved earth with this machine for a month at a time for as little as ⅓ cent per cubic yard put into the terrace ridge.

The only difference between this machine and the one used on highway construction work is the short delivery apron and larger size disk which is 32-inch. The elevator itself is approximately 10 feet long and the total cast from

HOURLY CHARGE FOR TERRACING EQUIPMENT USE

	48-in elevator and 75 hp tractor	42-in elevator and 50 hp tractor	Blade and tractor	Fresno-tractor-ripper or disk
Mechanic	$ .30	$ .30	$ .15	$ .15
Operators	1.20	1.20	1.20	1.20
Grease, No. 53	.16	.16	.12	.12
Oil	.10	.09	.04	.04
Rental; depreciation	1.00	.70	.61	.51
Fuel, at 5.5c	(6 gal) .33	(4 gal) .22	(3 gal) .16	(3 gal) .16
Gasoline, at 14.7c	(2½ gal) .35	(2½ gal) .35	.01	.01
Foreman	.30	.30	.15	.15
Repairs	.50	.50	.50	.50
Total	$4.24	$3.82	$2.94	$2.84

COST OF CONSTRUCTING TERRACES
(Five Weeks' Average)

1 Core—elevator job (1146 feet constructed per hour; 4.61 hours per mile of terrace; $4.25 per hour of operation)	
Core cost per mile of terrace (6 rounds)	$19.56
2 Blade work on terrace (1938 feet bladed per hour; 2.72 hours per mile of terrace; $2.94 cost per hour of operation)	
Blading cost per mile of terrace	7.81
3 Finishing work on terraces (2425 feet finished per hour; 2.18 hours per mile)	
Finishing cost per mile of terrace	6.18
Cost per mile (total)	$33.55
4 Fresno and ripper (8.4 hours per mile of terrace; $2.84 cost per mile of terrace)	
Fresno and ripper cost per mile of terrace	$23.85
5 Transportation of men (cost per mile of terrace)	5.30
6 Moving machinery (cost per mile of terrace)	2.98
7 Greasing (cost per mile of terrace)	2.37
8 Blading gullies (cost per mile of terrace)	1.07
9 Blading outlet channels—Average 400 feet per mile of terrace (costs 1.95% per foot)	4.78
Cost per mile (grand total)	$73.90

borrow pit to the terrace ridge about 16 feet. (This will vary slightly on different slopes.)

The lister furrow mentioned above is the guide line for the operation of the elevator. Our standard cross section of terrace calls for nearly all of the terrace ridge to be built with the elevator. Since the soil is picked up with the elevator and placed directly where it is to remain in one operation (no pushing and shoving around), it is necessary that each move with this machine be well planned and executed. Good tractor drivers and elevator operators are able to accomplish this with uncanny accuracy.

The procedure is as follows: On the first trip along the terrace line the outfit is driven so as to deliver the furrow slice 4½ feet over the guide line, the lister furrow. On the return trip, the cut is delivered in the same relative position. The second, third, fourth, fifth, and sixth rounds, as may be required, are cut and delivered to give the required yardage and shape to the ridge that is desired in so far as it is possible to accomplish it with the elevator.

When the job has proceeded thus far, we find we have a borrow pit both above and below the rough ridge of earth that has been placed on the guide line. The high spots that are usually a troublesome part of blade terrace construction have been eliminated ahead of the elevator work by use of the ripper and tumble bug, or rotary scraper, and we have a uniformly high terrace ridge across all low spots in the field, because all the fills have been made prior to putting the elevator on the job.

All that remains to be done to finish our terrace is to

shape the water channel and eliminate the borrow pit on the lower side of the terrace ridge.

These two jobs are accomplished with the 14-foot blade grader and a unit of heavy tillage disks.

The blade work is done in two rounds. The first round pushes an added yardage of earth to the toe of the elevator ridge, adding base width to the ridge and helping to shape the terrace cross section, and is made after the first elevator cut. This procedure permits lowering of the elevator carrier which increases the depth of the second and succeeding cuts. This adds materially to the yardage placed in the terrace ridge and increases the efficiency of the elevator. The second round has two jobs to perform. The up-slope borrow pit is partially filled, by backsloping the slope into the terrace channel. In this operation we partially cover the exposed subsoil of the terrace channel with top soil material, and lengthen, thereby decreasing the slope from the original ground level into the channel of the terrace. The lower borrow pit is treated in a slightly different manner. Some top soil is cut into it and at the same time the down-grade shoulder of the borrow pit is eliminated so that this borrow pit will carry no water.

One more operation and our terrace is complete, ready for the final check by the survey engineer.

Three heavy tillage disks handled by a 50-hp Diesel tractor are used to work down and accomplish the final shaping of the terrace cross section.

These disks are multiple hitched in the following manner: A wide spread hitch unit is used, the disks placed so that an offset double-throw disk is run on the terrace ridge slope. A regular tandem disk cuts up the bottom of our terrace channel and the area over which all the machinery has traveled in building the terrace ridge, while the third disk, another offset double-throw disk, cuts the back slope into the elevator borrow pit.

Discussion by E. V. Collins

IT SEEMS PROPER for me to be perfectly frank at the outset, and to admit that I am interested in the development of an unconventional type of terracing machine. My analysis of the job of terrace building is as follows:

1 The usually accepted design of terrace has a very small cross section as compared to road building or levee work. The maximum cut will average perhaps a foot in depth and tapers off in both directions. While this job is primarily one of moving earth sideways from the terrace channel, we are so limited in where we get the earth from and where we place it, that the machine which is most economical in moving earth is not necessarily the most economical machine for terracing. On account of the limited cross section of the job it seems preferable to have two one-man outfits rather than one two-man outfit, even if there were no greater overall efficiency.

2 As the terraces follow contour lines quite closely, they are often crooked, and a satisfactory terracing machine should build the curved portions uniformly with the straight sections.

3 If the terracing is to be done by a federal agency or county association, it is usual to start with a few terraces at the top of slopes rather than to complete all terraces on each farm in turn. This distributes the benefit over a large area sooner and permits the cooperating farmers to become familiar with cultivating terraced land and with the maintenance of terraces. It would seem then that a mobile type of unit is needed for terracing.

On the other hand, if the terracing is to be done by the farmer himself, then the terracing unit should be adapted to a tractor which can be used in the regular farm operations.

4 The finished work should present a pleasing appearance and offer minimum obstruction to the cultivating operations.

5 Undoubtedly terraces will have to be maintained at intervals depending on soil types, slopes, and methods of farming. For this work a mobile unit which will not tear up the sod by turning in the established outlets is needed.

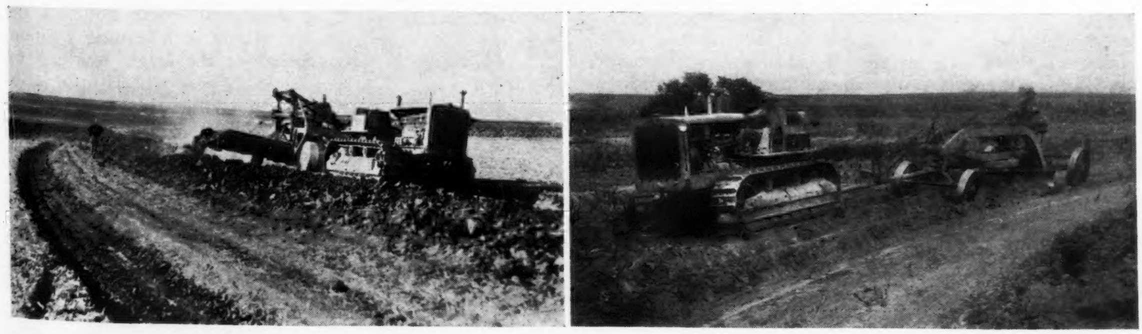
Author: Research agricultural engineer, Iowa Agricultural Experiment Station. Mem. ASAE.

Discussion by Leonard J. Fletcher

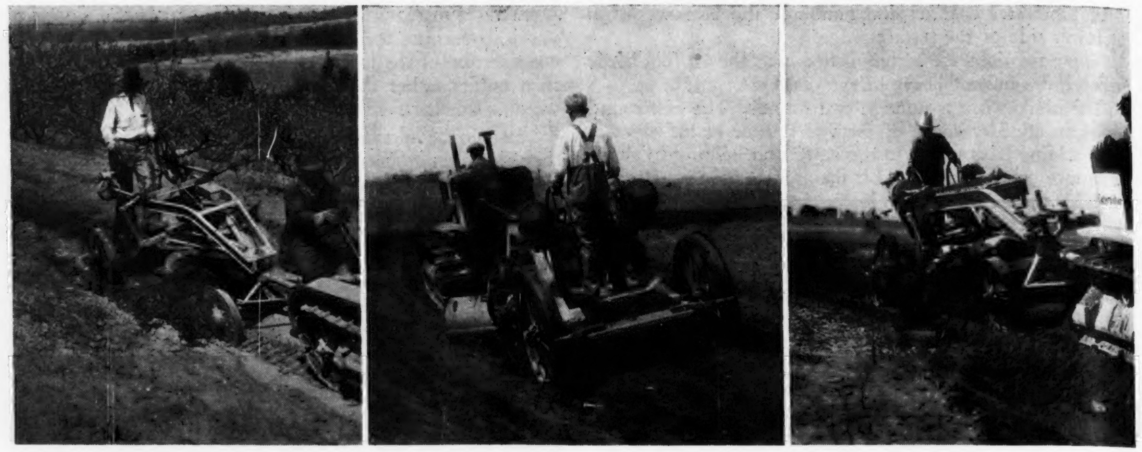
MANY ITEMS must be considered when a manufacturer sets out to design and build a terracing machine. Analyzing the earth-moving job of terracing is similar to analyzing the job of constructing an irrigation ditch or a road. In the average terrace approximately $\frac{1}{2}$ cubic yard of soil is moved per foot of terrace length. Sometimes this soil must be moved from below, as well as above the terrace ridge; and sometimes the soil is moved only from the upper side. In some cases the terrace line may be only a few hundred feet in length, as in the Southeast; whereas in the Great Plains area some terraces run for more than a mile before it is necessary to turn the machinery around.

The designer of a terracer must always keep in mind that his machine is to work on farm land, and the terraced field must be left in such a condition that the farmer can go right on farming it. A successful terracing machine moves the soil to the terrace ridge with the least amount of

Author: Agricultural engineer, Caterpillar Tractor Company. Mem. ASAE.



LARGE-CAPACITY CATERPILLAR TERRACING MACHINES—ELEVATING GRADER, LEFT; NO 66 BLADE GRADER, RIGHT



THE MODELS OF CATERPILLAR TERRACERS IN ACTION—NO 1, LEFT; NO 2, MIDDLE; NO 33, RIGHT

energy and leaves an absolute minimum of exposed subsoil and a uniform terrace channel.

In the spring of 1930 the agricultural sales department of our company requested the road machinery division to develop a terracing machine suitable for use with our smaller tractors.

After studying the then available terracing machines and the performances of standard road graders in terrace building, two experimental models were built. One followed the conventional road grader design having an arched main frame and independent circle frame with lateral adjustment. The other was of the frameless type, where the circle drawbars also serve as the main frame members, and the blade is controlled by raising and lowering the frame over the rear axle. Both were built for 15 to 20-hp tractors.

Both of these machines were equipped with short rear axle, flanged disk wheels, and gooseneck hitch, with front truck and stub tractor pole as alternative equipment.

After preliminary field tests near Minneapolis in the fall of 1930, the frameless type machine, just referred to, was abandoned due primarily to its lack of means for lateral adjustment of the circle and unsatisfactory performance in general.

The development work was then concentrated on the first-mentioned machine. Due to the lateness of the season no further field tests could be made at Minneapolis, and the machine was shipped to Dallas, Texas, where it was used in actual terrace building, and its performance checked with several other machines.

In this machine a secondary blade control means was arranged in a line parallel to the line of draft. Also the tractor used to haul it was equipped with a side seat. The purpose of this was to make possible the extension of the controls forward and operate the machine from the tractor seat making the unit a one-man outfit. It was soon discovered, however, that driving a tractor on terracing work and operating the terracing machine are each full-time jobs and when the test at Dallas was completed, and the machine returned to Minneapolis, the lifting mechanism was redesigned as now used on our No. 1 terracer. At this time the gooseneck hitch was also redesigned to provide adjustment for height, scrapers were added for keeping the rear wheel and flanges clean and effective, and heavier circle drawbars were provided.

In May 1931 the revised machine was shipped to Ames, Iowa, for further tests. We now found the general operating characteristics of the machine quite satisfactory, but it was agreed that further study should be given to the design of the blade to improve scouring qualities and to increase capacity.

Upon return to the plant several blades were made up from different materials of varying curvatures and of different heights. A field of about forty acres was leased and extensive tests were made on these blades.. A heat-treated, soft-center steel blade was finally selected as being the most effective from the standpoint of scouring, and shaped to the curvature which was found to give the best rolling action to the soil.

The terracer was finally approved and released for production about August 1, 1931. This machine is now known as our No. 1 terracer.

When it appeared necessary to provide larger terracing equipment for use in the Southeast, it was thought best to develop a larger blade machine. The disk and elevator idea was given due consideration and abandoned on account of the small size of the fields, the distance the soil was to be moved, and the presence of stumps and rocks. Therefore, the features of a leaning wheel grader were incorporated in a larger experimental terracer that was tried out throughout the Southeast.

The leaning wheel terracer with a 9-foot blade was thus developed, and was designed for use with a 40-hp tractor. Field trials of this terracer soon showed that the operator was so busy keeping the blade in proper position to move the soil to the desired point that he did not keep the wheels leaning in the right direction; consequently, the machine tended to tip over on side hills. It was also found that it was necessary to back the terracer under many conditions, especially when turning at the end of short terraces, and that the operator on the tractor could not back the terracer accurately with the wheels in a leaning position. Therefore, in the final design of the larger machine we returned to the rigid (or straight) rear wheels in order to simplify the machine, principally from the standpoint of control.

The gooseneck terracer is not new; however, a large gooseneck hitch terracer had not been developed until 1933. The reason for the gooseneck hitch was to enable the outfit to maneuver in the small fields encountered in the Southeast and elswhere in the Middle West, and to simplify the machine so it could be used for building flat-bottom terrace outlets, diversion ditches, etc.

It was found in this terracing work that greater stresses were sometimes placed on terracing machines than were encountered on regular road-grading or ditching work;

and for that reason a new type of frame was used, called the "box type" frame. Therefore, in the finished No. 2 terracer, we find a simplified machine with a frame that will take compression, as well as tension and twisting strains, and with the adjustments required to meet the wide variables encountered.

When moving soil from the terrace channel to the terrace ridge, also in knocking down some of the old bench type terraces that exist in the Southeast, it was found that a generous side shift of the circle was necessary; in fact, a 30-inch side shift was needed in order to reach out beyond the tractor to plow down old bench type terraces.

When moving large quantities of soil a distance of 10 to 14 feet into a ridge, and doing so in large fields, the elevating graders may be profitably employed. An elevating grader is more expensive, more complex, and less adaptable to variations in contour. In order to justify the use of such equipment there must be a large amount of terracing work to do, as well as large terraces requiring the moving of considerable soil. When an elevating grader is used for building terraces it must have sufficient weight to make the disks penetrate deeply into the soil, so that the crop-producing top soil is not stripped from too great an area. It must also be remembered that supplementary machinery —rotary scrapers and blade graders—are required to finish the terrace built with an elevating grader.

In these large field regions, such as Oklahoma, Texas, Kansas, Colorado, and Nebraska, there are also conditions where the standard large road grader can be used with the large tractor for building terraces economically. These graders should have at least 12-foot blades. Whenever it is possible to use a standard piece of equipment that can be used for other work, naturally the cost of manufacture and subsequent cost to the user is less.

However, there are many conditions throughout the United States where the heavy earth-moving equipment, such as elevating graders and large blade graders suitable for 50 to 75-hp tractors cannot economically be used.

MANY IDEAS PRESENTED FOR TYPES OF MACHINES FOR BUILDING TERRACES

Since terracing has recently been given such wide attention, there are being presented many ideas for various types of machines for building terraces. There is no doubt but that the wide variation in soil types and contours will permit the use of machines of different designs. There is only one real requirement; the terrace must be made with a uniform water channel, as few kinks as possible, with a ridge that will prevent overtopping by heavy flow of water, and built at a cost within the farmers' reach.

One machine which has been discussed to some extent might be described as a once-over terracer. In theory this machine would be designed with some sort of a frame, adjustable within certain limits and about which would be operated a chain equipped with cutting and carrying buckets. This device would be pulled along the line of the terrace, the buckets cutting out the terrace channel and depositing the soil in the ridge forming the completed terrace in one operation.

Since there is quite a similarity between the terrace and the ordinary type of earth road, it might be interesting to study the developments of a machine for building earth roads. A manufacturer in Illinois sometime ago brought out a machine known as a road-shoulder finishing machine. This device was intended to dig out the ditch, spread the soil evenly over the top of the road or along the side of paved roads, and form the shoulder. An examination of the success of these machines indicates that conditions are not sufficiently uniform to warrant the use of once-over machines. If this is true of earth roads, it would be more true of terraces, because of the curves, the encountering of ditches and ridges, stumps, rocks and the necessity for short turns, sometimes close to road banks where it would be difficult to maneuver the large once-over machine. There seems to be considerable evidence to substantiate the belief that a terracing machine must be reasonably versatile in its ability to meet variable field conditions.

Discussion by R. W. Baird

THIS DISCUSSION will be based upon experiences in terracing in Texas. The work that has been done at the Tyler Experiment Station has been recently reported. Some ideas have been obtained by observations in the eastern one-third of the state.

It is probable that there is as great a variation in field conditions throughout this area as in any section of similar size in the United States. Fields vary in size from small patches to large fields; soil types, from heavy blackland clays to loose fluffy sands; and topography, from badly broken steep slopes to gently rolling prairies. The assumption that one definite kind of terrace would be most effective under all these conditions is probably not justified.

The problem of design of terracing machinery is retarded some by a diversity of opinion as to what a good terrace should be. From the viewpoint of the soils expert, a terrace which is constructed of subsoil with a layer of surface soil of normal depth over it would be desirable. Such a terrace would be expensive to construct, and the benefits probably will not pay for the added expense.

On most agricultural soils it seems to me that the kind of terrace built will be determined by the factor of economy in construction. In other words, a definite capacity is required plus a size factor depending upon the machinery that is to be used in farming, and the cheapest way the two requirements can be met is probably the most practical. This leaves us the choice of machines with which to build the desired terrace.

Some type of blade grader is the machine usually considered the most economical in the moving of earth short distances. In terrace construction the problem is somewhat more complex in that most of the earth is also lifted from a few inches to as much as 18 to 24 inches. This lifting action required puts an added load on the blade graders. Other machines have been used and under certain conditions have been economical to do the required job of moving earth.

The size of equipment to use will depend largely upon the amount of work to be done and the layout of the fields. Where both can operate without too much lost time in turning or moving, the larger machines will construct terraces more economically than the smaller machines. Small terraces such as have been used at Tyler on pasture land can be economically built with small equipment. The recommendations as to equipment for terracing work prepared by engineers from the Soil Conservation Service and ECW at Oklahoma City early this year seem reasonable.

After the terrace construction work is completed, we still have the problem of terrace maintenance. On most soils and slopes the greater part of this work can be done in plowing by backfurrowing to the top of the terrace ridge. At the Tyler station a two-way plow is being used on terraced land to maintain terrace size and channel capacity. The dead furrow is left in the terrace channel and all of

Author: Associate agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. Mem. ASAE.

the furrows are thrown uphill. With this method of plowing it is not necessary to turn the plow and tractor on plowed land. From careful surveys of terraced land plowed with a two-way plow this spring, it was found that the cross sectional area of the terrace ridge was increased 0.42 square feet, and that of the channel was increased 0.92 square feet. This is probably sufficient under the conditions in this field to care for the wearing down of the ridge by cultivation and erosion and the filling of the terrace channel for one year. These surveys were made just before plowing and again after planting the crop of corn. The field was disked with a tandem disk harrow and harrowed with a three-section, spike-tooth harrow before planting. There were no rains causing runoff between the two surveys, so that the soil movement measured is entirely that due to cultivation practices.

An Absorptive Agent for Drying Grain

By W. M. Hurst and W. R. Humphries

PRESENT PRICES of chemical driers prohibit their use for grain, but the subsequent discovery or development of an inexpensive material might make feasible the drying of some farm products by this method. The mixing of the drying agents with the grain and its removal by screening is believed to be relatively inexpensive, but little is known regarding the cost of drying the chemical for reuse on the farm.

Results of observations and tests made with grain driers used in country elevators show that the operating expense (power, labor, and fuel) of such units is low, but that the overhead cost per bushel of grain dried may be exceedingly high unless a large quantity of grain is dried annually. In most cases a grain drier is needed on the farm only during wet harvest seasons. For this reason and due also to the high initial cost of commercial grain driers, few are used on farms. There is, however, a need for grain drying on the farm.

Farmers have been known to place boards and blocks of wood in granaries to absorb moisture, thus reducing the moisture content of the grain sufficiently low for safe storage. Calcium chloride and sodium chloride and some other chemicals have a high affinity for moisture, but would doubtless have an injurious effect on grain, and they deliquesce when saturated with moisture. Several products recently placed on the market have a high affinity for moisture, but are chemically inert and do not deliquesce when saturated. The water absorbed can be evaporated by heating and the product used again. Some of these chemical driers can be conditioned or activated an unlimited number of times, but must be stored in airtight containers to prevent the absorption of moisture from the atmosphere while not in use.

A small lot of an inert silica product was obtained in November 1932 and tests made to determine its practicability in drying grain. In conducting these tests 400- or 500-gram samples of wheat, soybeans, flax, corn, and rice were used. The moisture of the grain was determined and sufficient water added to increase the moisture content to 20 per cent. After the water was added, the samples were kept in airtight containers for approximately 48 hours, in order that the water would be absorbed by the kernels before the drier was mixed with the grain. The drier, the equivalent of four times the weight of water added, was then placed in the container and mixed with the grain by shaking and tumbling the container. The container was then sealed and allowed to stand for the desired length of time. Four or five such samples were prepared for each kind of grain. The manufacturers of the product used were of the opinion that the substance would absorb at least one-fourth of its weight in water when so used. At the end of 24- or 48-hour periods, the grain and chemical drier from one of these receptacles containing a particular kind of grain was separated and weighed, and a moisture determination made of the grain. The process was repeated at 24-hour intervals until all of the samples had been used up. Two series of such tests were made with wheat, three with soybeans, and one each with flax, corn, and rice, as is shown in the accompanying table.

The table shows that the moisture content of the sample of grain, soybeans, and flaxseed was reduced from 20 to 14 per cent or lower in from 24 to 48 hours. The samples in which the grain was left in contact with the drier for more than 48 hours showed, in most cases, a further reduction in moisture. It is, however, not necessary for safe storage to reduce the moisture content of grain much below 14 per cent under present storage practices. From this it would appear that the drier used would absorb more than 25 per cent of its weight of water in reducing the moisture content of grain from 20 to 14 per cent. In case it would absorb 33⅓ per cent of its weight of water from grain, approximately 12½ pounds of the product would be required to dry one bushel (60 pounds) of wheat. In few cases, however, would grain have a moisture content as high as 20 per cent when threshed. In case it had 18 per cent moisture and the drier would absorb 33⅓ per cent of its weight of water, approximately 7½ pounds would be required per bushel of wheat to reduce the moisture content to 14 per cent.

Authors: Respectively, associate agricultural engineer (Assoc. Mem. ASAE) and chief engineering aide, Bureau of Agricultural Engineering, U. S. Department of Agriculture.

ABSORPTION OF MOISTURE FROM GRAIN BY A CHEMICAL DRYER

Grain				Moisture content of grain					
						After being mixed with drier			
Kind	Weight of sample, grams	Water added, grams	Drier* used, grams	Before wetting, per cent	After wetting, per cent	In 24 hours, per cent	In 48 hours, per cent	In 72 hours, per cent	In 96 hours, per cent
Wheat	500	43.2	172.8	13.3	20.0	15.3	12.8	13.3**	
Wheat	400	29.0	116.0	14.2	20.0	13.3	13.2	12.1	12.3**
Soybeans	500	69.4	277.6	8.9	20.0		11.3	9.4	10.5**
Soybeans	500	65.0	260.0	9.6	20.0	13.4	10.0	9.4	
Soybeans	500	66.8	275.2	9.0	20.0		12.1	10.6	
Flax	500	69.4	277.6	8.9	20.0		13.7	12.9	8.0
Corn	400	32.5	130.0	13.5	20.0	13.4	12.7	12.1	11.5
Rice	500	33.8	135.2	14.6	20.0		13.7	12.8	9.9

*Drier was mixed with grain 48 hours after grain was wetted.

**Apparent increase in moisture doubtless due to improper mixing of drier and grain in individual containers.

Engineering Phases of the REA Program

By W. E. Herring

IT IS MY understanding that most of you are engineers and that perhaps the majority of the men present are connected with the Extension Service of the Department of Agriculture. This being the case, I am of the opinion that you probably are more interested in certain engineering phases in connection with this work than you are in some of the other purposes. It might be well, however, to start by saying that Rural Electrification Administration was created for the purpose of extending electric lines into rural areas now without such service. This immediately means that there will be no duplication of existing lines. Neither would we make loans for the purpose of building lines to reach properties that now have electric service or to whom electric service is available.

The extension of these lines can be accomplished in two ways, first, by means of loans which the REA will make to power districts, municipalities, privately owned utilities, cooperatives, or similar groups of people who obtain legal standing in their state. The second method of course would be through extensions made by privately owned utilities with their own funds.

We make loans on approved projects only and cannot deal with a few individuals on short pieces of line. A project which may consist of several pieces of line in a contiguous territory, should show a total of at least 25 miles of line in order that we can economically handle it. Our requirements for the approval of a project are comparatively simple. First, no grant will be made in connection with the construction; second, all projects must be self-liquidating over a twenty-year amortization period including interest at 3 per cent; and third, no loans will be made for the duplication of existing facilities.

We can also make loans for the construction of generating plants, but we must be shown very clearly that, in an application for a loan of this kind, energy can be produced on the switchboard at a price lower than it can be secured from any other source. It is possible for us to loan to a municipality, for instance, funds for increasing their generating capacity, provided the increased capacity covered by the loan is to be used entirely, or practically entirely, to supply a rural load.

In the preliminary step, in an application to us we require very simple information, such, for instance, as the length of lines proposed to build, the number of customers, and a statement as to the approximate amount this group of customers could spend per month for electric energy—this information to be accompanied by a map on a reasonably sized scale showing the proposed lines. This information is kept in its simplest form for the reason that we do not want any group of people to incur any expense until we have an opportunity to determine whether or not the project looks feasible from our standpoint. Any group of serious people who are interested in securing electricity can furnish this information. After we have studied the project and determined that it is feasible, there are other questions that must be answered. We shall want to know the point or points where energy will be obtained for the operation of the project, the voltage of those lines, and length, and in many cases the capacity of the lines. This, you all understand, is necessary so that the proposed system can be properly laid out.

Line losses, the voltage to be used on the project, the amount of three-phase line, whether it will be three-phase, three-wire, or three-phase, four-wire, which will depend of course upon the source of supply. Many other technical questions of this kind will need to be known. This means that it will be necessary for us to have an engineer visit the project and check over the technical details in connection with it. We will not, however, do the work for the sponsors of the project. It will be necessary that they employ an engineer who is competent to lay out their system and submit it to us for approval. This step, however, is not necessary until the sponsors are practically assured by us that the project will go through.

We have been asked many times in regard to the figure of $1,000, which we use as the cost of a mile of single-phase line. We realized at the outset of our work that some dollar figure would be necessary as the cost of a mile of line. After getting information from different parts of the country regarding line costs, we worked out the costs on a hypothetical line including three customers, three kva transformers, three services, and three meters. Long-span construction, that is, an average span length of 300 feet, was used, together with 30-foot Class 6 poles. Carefully prepared estimates on this type of work disclosed that $1,000 per mile would cover the cost.

Mass construction was considered, that is, the construction of 100 or 200 miles of line at a time, as distinguished from piecemeal construction. We had the opportunity to check these figures with several operating companies, and the only difference disclosed was in labor costs, due to different rates of pay in various parts of the country and to the amount of overhead included in the costs. The material cost checked all the way through within a surprisingly small percentage. We realized thoroughly in setting up this figure that it would not cover all costs in some parts of the country where the roads were crooked, where there was rock to be blasted for pole holes, where tree trimming was heavy and difficult, but that in other parts of the country, say, in the Middle West, where there was no tree trimming, where the roads were straight and maximum span lengths could be used, the cost would be lower even than this figure.

We had figures from operating companies showing actual costs on completed work for single-phase primary lines running from $510.00 to $560.00 or $570.00 per mile. If transformers, meters, and services had been included in these prices on the basis of these primary line figures, the total would have run something on the order of $810.00 to $860.00 or $870.00 per mile. It is very interesting to note in connection with these costs which we have been advocating, the change in the ideas and the costs of a number of the privately owned utility companies. One large company told us that their primary line costs, only, for single-phase line were $1,400.00 per mile. This summer, after the completion of some 400 miles of such line, the president of that company told me these costs had been reduced to slightly over $1,000.000 per mile and that they looked for them to be still lower. This

Presented before the Rural Electric Division of the American Society of Agricultural Engineers at Chicago, December 4, 1935.

Author: Special assistant to the administrator, Rural Electrification Administration.

happened to be in an area where tree conditions were bad, roads were crooked, and many holes had to be shot. They also used a heavy conductor and are in the heavy loading zone. I still feel that their primary line costs should be further reduced and am of the opinion that their future work will show material reductions. Other companies who have heretofore held to a 30 to 35 pole per mile job in the rural areas are now going to long spans, using 18 to 20 poles, and these lines, of course, will show much less cost.

With a line such as described, that is, an average of three customers per mile, we estimate that it will be necessary for each customer to utilize 100 kwh of energy a month if the line is to pay out.

Another question which has been raised many times has been as to the amount of line which we would include on a customer's private property, that is, in his service line. At first, we decided that only 150 feet of service would be allowed free on a customer's property. This is usual utility practice throughout the country. Recently, however, I have found instances where a part of the line in excess of 150 feet has been furnished by the company and charged in as a part of the cost of the project. In certain areas from which we have had projects, the sponsors have told us that 150 feet of service line would not reach many of their customers. After going into this situation in several states, we have decided to increase the length of line which we would build on private property to one pole and one span of wire in addition to the service drop of 150 feet. It would be possible under such a condition, therefore, to reach a house 750 feet from the main line by using a 600-foot span to the pole which we will supply.

REA HAS NO JURISDICTION AS TO RATES OR REQUIREMENTS COVERING RURAL LINE EXTENSIONS

We have stated repeatedly that REA has no jurisdiction in regard to rates or requirements covering extensions of rural lines. We recognize that this is distinctly within the province of the state regulatory body. However, it is necessary for us to give consideration to the proposed retail schedule for the reason that on any project the fixed and operating charges accrue and carry on whether or not any use is made of the line. Therefore, it is essential in our analysis that we take cognizance of the revenue that would be obtained under the proposed rate schedule. If that is not sufficient to meet the annual charges, it is necessary that a different rate schedule be adopted. If it is more than enough to cover these charges, a lower rate schedule could be used. Naturally, customer density determines the per customer cost. The more customers the less revenue required from each customer, but, as you understand, this amount does not decrease in the same proportion as the number of customers increases.

It is interesting here again to note the changes that have taken place in the last two or three months with numerous of the utility companies. Rural rates have been lowered in many areas, and line extension requirements have been lessened so that rural service is now available on more reasonable terms to a great many people who have heretofore been without electric service. The vision of the different utility companies shows marked contrasts. Some of them are confident enough, apparently, in their ability to build up the usage on rural lines and thus have established line requirements that are comparatively easy for the rural customer. Others still feel that the only lines they can build are those that will show a substantial consumption immediately. Past practice with the utilities of course has been to undertake only those lines that would meet their rather adequate requirements in regard to pay out, and one bad feature in connection with their work has been that they did not look at the area as a whole, but looked at individual lines. Recent events along these lines indicate that the companies are beginning to take a broader outlook, to realize and appreciate that an area has been set aside for them in which no one else can compete and that there is a moral obligation on their part to supply that area. This is perhaps evidenced by the new requirements of the Niagara-Hudson Company in New York state. Under this new requirement, the company will make an extension of 1,500 feet at a $2.00 a month minimum. In other words, a mile of line will be constructed at company expense for a guaranteed return of approximately $7.00 per month. Certainly this is a great step forward in this work.

We have prepared some suggested standards covering line construction. These are mainly drawings of pole tops showing wire, insulator, and pin arrangement, together with transformer and wiring arrangement. They will cover both flat and vertical construction. They are not necessarily to be adopted by anyone but are, as we stated, suggestive. If we are dealing with a group that has had no experience in the construction of distribution lines and their engineer wants something as a guide, we can furnish him with a set of these plans. He can use them as we have drawn them up or make such necessary modifications as he desires. I want to make it plain that they are not to supersede present practices of any organization to whom we may loan money, unless that organization desires to use them.

APPLIANCES PURCHASED ON INSTALLMENT BASIS THROUGH ELECTRIC HOME AND FARM AUTHORITY

From what I have said in regard to changes in line requirements and rates, it follows that I do not believe it would be entirely fair to attempt to measure the accomplishments of REA in the size of or number of loans so far made. These other results which are being attained are in a measure perhaps of greater importance, or at any rate significant. Unquestionably, as you men probably know, there is a change in the attitude of the operating companies toward their rural areas, and this change undoubtedly works out to the benefit of the prospective customer.

Through the Electric Home and Farm Authority, electric appliances can be purchased on the instalment basis. I believe their plan calls for 36 months' time on one major appliance, but if two major appliances are purchased, 48 months is allowed to pay for them. REA is now contemplating loaning money for the wiring of farm houses and buildings and also for the construction of line on private property in excess of the amount which will be allowed free. Shortly after the first of the year, these plans should be completed and ready for announcement.

It seems to me that you people who are connected with the extension service have a common cause with us in that you are particularly interested in seeing as complete coverage as possible of all the rural areas in your particular state. We hope to have closer contact with you through an engineer who will be available about January 1 and whose sole duty will be to act as liaison engineer between the extension service and the REA. There are many problems, most of which are of comparatively minor importance, that can and will be readily worked out. It is useless for me to tell you that we shall be very happy to answer any questions concerning our work.

The Agricultural Engineer — Technician or Engineer

An Agriculture to Fit the Tractor

By Harold E. Pinches

"SHOULD not the effort of agricultural engineers be turned toward an agriculture to fit the tractor instead of trying so hard to adapt the tractor to traditional agriculture?" This question was raised in my paper in AGRICULTURAL ENGINEERING for December, 1935. It suggests the larger question: What is the function of the agricultural engineer as related to all farm machinery?

Various factors have frozen agricultural production units into typical forms. The Homestead Law, the amount of land a man and team could plow in a day, the amount of land that could be bought by the efforts of one man through his active lifetime, even the accidents of the English system of measures have had their influence in establishing our present farms and farming practices. It is usually safe to assume that there is some kernel of practical wisdom gained from general experience in an established form. But we should be ready to recognize when an old form is outmoded and should give way to the new. To be on the lookout for better forms to take the place of the old is one of life's greatest adventures, and is, also, the way to avoid needless loss and delay in the forward march of civilization. Such a step forward seems possible in the old, old task of gaining food and shelter.

It probably has been necessary to advance a step at a time with machinery that farmers ("as is") could or would buy. Only thus could be found the large funds which have been necessary to change from the cradle to the combine, from the dung fork to the manure spreader, from two-wheeled cart to speedy truck, from four-legged power to four-speed tractor. But a time has come when effort should turn, from adaptation of the new to the old, to the building of the agriculture that is possible with these new developments as its base.

A man and team can plow only about so much land in a day. A good plowman with a good team can do but little more than the average. The amount that can be plowed by a man and team, using the typical tools of a region, in the time allowed for that operation by the average weather of the locality, will determine in part the size of fields to be found there. But the fields so established, and usually taken so much for granted, are often a considerable factor of inefficiency in the use of a tractor. So tractors had to be made smaller—at higher cost per horsepower—to approach the original horsepower of established farms.

That is not to say that large machines are desirable *per se;* efficiency does not necessarily come with increased size of machine or of farm. McKibben showed in his study (1930) that efficiency of field machines does not increase in direct proportion to increase in either width or operating speed. Some years ago, M. L. Wilson showed that efficiency in wheat growing under Montana conditions increased (as measured by cost per bushel) as the size of tractor increased up to 60 horsepower. A study by Fletcher and Kinsman in California (1926) showed that for farm uses there (10,000 horsepower-hours field work annually), a tractor of about 15 drawbar horsepower produced the lowest cost power. New developments in capacity and versatility of tractors and machines probably have changed these relationships.

Such studies show the approach which agricultural engineers should use continually in considering farm power and machinery. It should be possible, under some auspices, to study and plan for the best combinations of land, labor, and capital (mechanical and financial forms). The studies should include machines reasonably possible—whether salable under present farm organization or not. They should attempt to discover best regional units of land and machinery for the major crops. They should consider the possible correlation or best combinations of crops for each region—combinations which will give good load factors with a minimum of peaks.

For example, there are areas where wheat and cotton are grown, both using some of the same machinery but at different seasons of the year. In this same region, sorghums and kaffir corns are grown, requiring attention at still other times. What acreage of each—possibly combined with fallow acreage for moisture and weed control—makes a good combination? What special machines (one-crop machines) can be eliminated through study of operations from a functional point of view? In other areas wheat, corn, soy beans, and alfalfa lend themselves to a variety of combinations. Is the usual method of planning acreage of each crop on a farm, according to the feed requirements of the livestock kept on the farm, the best guide? Can good animal husbandry overcome inefficient crop production? Is not crop production fundamental? And is not crop production largely — so far as it is within the control of man — a problem of control and application of energy through mechanisms?

It is apparent that no answer is known to some of these questions; some may be debatable according to one's viewpoint or experience. But these, and many others that could be asked, point the way to a field of inquiry which agricultural engineers might well enter.

An approach to the problems of farm power and machinery as a study of functions and functional requirements should be made—forgetting, for the sake of the study, both salability and traditional agriculture. One of the latest announcements is a "streamlined tractor". Streamlining may be all-important in a 300-mile-per-hour airplane, or in a coiffure, but is it in a farm tractor? Contrast this with the engineer and the agronomist who are working together on a "soil combine"—a machine to give some measure of *positive control* over soil granulation under varying conditions of soil type and moisture content.

Such a functional study of crop-production operations and the relations of machinery thereto will reveal "bottle-

Author: Assistant professor of agricultural engineering, Connecticut State College. Mem. ASAE.

necks", such as cotton picking has long been known to be. A study attempting to balance crops combinations will discover restrictions not generally recognized when each crop is considered separately. For example, fifty acres each of corn, wheat, and alfalfa might be discovered as a desirable combination for a certain crop rotation scheme and for a certain labor and machine organization. But, if only thirty-five acres of corn could be handled by that organization, it would disrupt the rotation scheme, or introduce a factor of extra cost to handle the remaining fifteen acres of corn. The problem then would be to discover where the restriction lay and to devise means for its removal.

All that has been said about crops production applies equally to those secondary processes, whereby the crops are prepared for animal feed or are started on the road as raw materials of industry.

The questions asked here may sound like questions of farm management. They are that, certainly, but they are more. They do not involve any attempt to solve the problems of an individual farm; they do involve an attack on the major problem of crops production. The program of agricultural engineering in this realm should be to show a better way of agriculture. Farm management would be one phase of the whole problem. Some other phases that are obvious are those of machine design, plant breeding, land economics, soil and fertility conservation, personnel.

Some aspects of the program proposed here are shown in the work being done by the Institutes for Research in Economics and Agricultural Engineering, University of Oxford, arising out of farm management problems on the St. John's College farm: "In recent years the owners of large arable farms in the south of England found themselves in an unhappy position. The traditional system of farming, based on corn, arable, sheep, and winter-feeding of cattle has been almost consistently unprofitable for more than a decade. . . . .

"(On about 480 acres) it was decided to plough out the comparatively small area of grass and to institute a system of mechanized farming over the whole area. The reblocking of the land necessarily involved a good deal of miscropping during the first two years, but even when this amounted to the planting of a third or fourth consecutive corn crop the necessary consolidation was carried out. . . . . The problem of the best means of disposing of the straw is receiving attention. . . . . .

AN EXAMPLE OF AN ATTEMPT TO SET UP AN "ENGINEERED" PLAN OF AGRICULTURE FOR ONE REGION

"The original area of 340 acres was equipped with one International trac-tractor and one Fordson tractor. With the raising of the acreage to 480, an additional International of the same type has been added. So far this amount of tractor power has been found adequate. . . . .

"Experience has been sufficient to show that the regular staff of three skilled men would be adequate for a somewhat larger acreage than that composing the present farm. One additional man is required during the autumn sowing period in order that the drill may be manned and all three tractors kept in work. During harvest a staff of six or preferably seven is required. . . . . . Work on the summer fallows is hardly sufficient to provide full economic employment for the regular hands, and a matter of fifty acres of hay would provide useful full-time work in June. Again in January and February there would be a difficulty, apart from the drainage operation . . . . . , in keeping the staff usefully employed. . . . .

"It is not the intention to rest content with the present organization even if the financial results are satisfactory; but rather to add to the enterprise, step by step, as experience is gained. The first addition contemplated is a one-man pig unit (about 300 head) . . . . The introduction of some vegetable crops for canning may possibly follow . . . . The ultimate hope is that something like the old number of men may again be employed, and that meanwhile the output will have been raised to such a level as to provide an adequate wage for every member of the staff and at the same time provide a fair return to the College." (Farm and Machine, vol. I, 2nd ed., pp. 51-56.)

From this lengthy quotation we get an interesting review of one piece of work being carried on in the spirit of the program for agricultural engineering as proposed in this paper. In so far as the work is concerned with the particular problems and limitations of St. John's College farm, it is farm management. But, as a bold-visioned attack on the problems of a region, it presents an attempt to set up an "engineered" plan of agriculture for the region.

The full report, from which the quotation is taken, presents, in a few pages, a plan involving the concurrence of many of the elements of any agricultural engineering program of crops production: the physical factors—acreage, soil type and soil fertility, climate; the social and economic factors—land tenure, financial resources, previous systems of farming, market outlets; power and machinery factors—adequacy or inadequacy of power, machine capacities and limitations, effects of weather, load factor; personnel—number and types of men, labor peaks and idle periods; and, finally, the test of the whole program—the efficiency of the program as measured by income to the workers, capital return, a minimum of permanent labor displacement, adaptability to further improvement, reduced cost of production.

ALL FACTORS IN AGRICULTURE, IN ADDITION TO MACHINERY, MUST BE CONSIDERED BY THE ENGINEER

Other factors, in addition to those mentioned, would enter into the formation of any complete agricultural engineering program for crops production. No single or simple set of principles of mechanics could furnish the basis for such a program. Nor would such a program be the work of any professional agricultural engineers. They would need the active cooperation of machinery experts, land economists, farm management specialists, plant breeders, meteorologists, and many others. The agricultural engineer thus becomes the one who coordinates a vast amount of scientific and technical knowledge and out of it compounds a plan for the fundamental agricultural activity—crops production.

The conclusion to which we have come possibly seems to be a long way from the question with which we started. By definition, the agricultural engineer might be limited to the strictly technical phases of farm machinery; then by definition, he should be known as a farm machinery engineer (in the sense of technician, specialist, expert). But the job of working out some such program as is called for here would remain to be done. If the engineer starts out to discover his function as related to farm machinery, he must go on to discover the function of that machinery, in itself, and as related to all the other factors of the agriculture of which it is a part. Function is not static or self-contained, it arises only out of interaction of two or more factors. The engineer's peculiar job, in any field, is to discover functions, make use of them, modify and control them in the organization and execution of a progressive plan of attack on a given problem. Our problem as agricultural engineers is that of agricultural production.

Rate of Wear of Spray-Gun Disks

By O. C. French

DISKS for spray guns are usually given very little consideration as being an important part of a spray plant. Frequently a disk needs replacement because of the orifice being worn, yet it is retained in service until adequate pressure can no longer be maintained. The effectiveness of a spray application depends to a great extent upon the performance of the spray disk. If the orifice in the disk is too small, the spray stream does not carry well and poor coverage results. If the orifice is too large, material is wasted. The sprayer manufacturer as well as the operator would like to have a disk that retained the original size orifice over a long period of time, not necessarily because of the cost of the disk, but from the standpoint of effective spray application.

Disks cannot be expected to last indefinitely, but it is possible they can be made from some material that is more resistant to abrasive wear than are the present disks. With this possibility in mind, I have conducted tests to determine the rate of wear of six different kinds of spray disks. The description of the materials of the disks and their Rockwell hardness numbers are shown in Table 1.

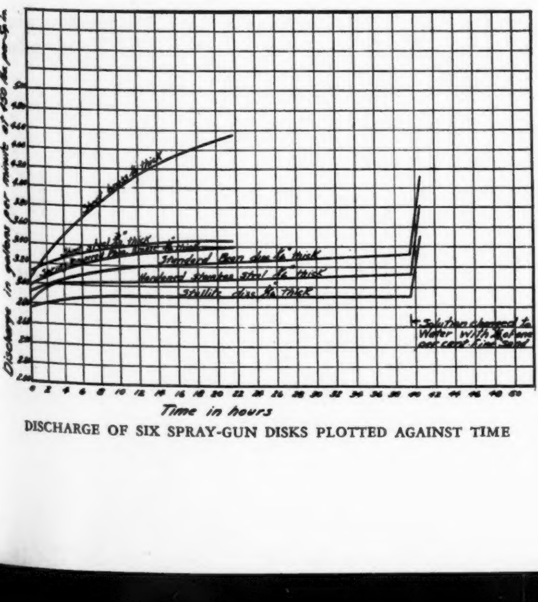
TABLE 1. MATERIALS, HARDNESS AND DIMENSIONS OF DISKS TESTED*

Disk No.	Material of disk	Thickness, in	Diameter of disk, in	Diameter of orifice, in	Rockwell Hardness No.
				No. 44 drill	
1	Spring-tempered phosphorus bronze	1/16	1 7/16	0.0860	B-97
2	Sheet brass	1/8	"	"	B-69
3	Sheet steel	3/32	"	"	B-55
4	Nickel steel (Standard Bean disk in 1935)	1/16	"	"	B-95
5	Hardened stainless steel	1/16	"	"	C-54
6	Stellite	1/16	"	"	C-58

*The disks were furnished by John Bean Mfg. Co., and fit the Bean Fig. 789 spray gun

The Rockwell hardness number is a physical measure of the comparative hardness of metals. The larger the number, the harder the metal. Rockwell numbers prefixed with C signify harder material than B numbers.

Author: Agricultural Engineer, University of California. Jun. ASAE.



DISCHARGE OF SIX SPRAY-GUN DISKS PLOTTED AGAINST TIME

The disks were tested by forcing Bordeaux (5-5-50) spray solution through them at a pressure of 450 pounds per square inch. The lime used in making the Bordeaux was of the ground-hydrated type. Bordeaux mixture was placed in a stationary spray plant tank and three guns mounted so they discharged back into the tank. The spray solution was pumped through the disks over and over again until ten hours time elapsed at which time fresh Bordeaux was supplied. Before starting the tests the discharge in gallons per minute at a pressure of 450 pounds per square inch was determined for each disk. At regular intervals after running Bordeaux through the disks they were again checked for volume of discharge at 450 pounds per square inch. By this method the rate of increase of discharge was determined.

The results of the tests are shown graphically in the accompanying curves, which show the discharge of the disks plotted against time. The sheet brass disk was the only one that showed very rapid wear with Bordeaux mixture. A large part of the wear of each disk occurred during the first few hours which probably resulted because the rough edges left by the drill were rapidly worn away.

After running the tests for as long as 39½ hours, the difference in discharge of the standard Bean disk and the harder disks was not as great as might be expected. The conclusion was that probably much of the wear of disks is caused by water which has fine abrasive material in it rather than abrasion by the spray mixture. An arbitrary amount of 0.25 per cent of sand that passed a 48-mesh screen was then mixed with clear water and run through the three disks as indicated in the chart. More wear occurred in one hour with this mixture than occurred during 39½ hours when using Bordeaux. This is probably an explanation of why some spray operators have to change disks more often than others.

Table 2 shows a tabulation of the increase of discharge of all the disks after using Bordeaux, and also for three of the disks after one hour with water containing fine sand.

TABLE 2. RATES OF INCREASE OF DISCHARGE, IN GALLONS PER MINUTE

Disk	Discharge of disks at beginning of test	Increase at end of 21½ hours with Bordeaux	Increase at end of 39½ hours with Bordeaux	Increase from 1 hour with sandy water	Discharge of disk at end of test
Spring-tempered phosphorus bronze	2.98	0.40			3.38
Sheet brass	3.04	1.51			4.55
Sheet steel	3.12	0.33			3.45
Standard Bean disk	2.92	0.33	0.42	0.78	4.12
Hardened stainless steel	2.82	0.26	0.32	0.68	3.82
Stellite	2.76	0.14	0.15	0.59	3.50

The Stellite disk offered considerable greater resistance to wear than the other disks. If clean water could be obtained, a Stellite disk would very nearly retain its original capacity during many hours of use, and under these conditions the additional cost of this *(Continued on page 88)*

A Nomographic Chart for the Iowa Dynamometer

By June Roberts

A NOMOGRAPHIC chart may be constructed for the Iowa dynamometer. By the use of this chart and a straight edge, the horsepower may be read directly. The chart has about the same accuracy as the ordinary slide rule and saves much time in calculations, which is particularly useful in experimental or class field work where a certain load is wanted, or it is desirable to know the horsepower being developed by a tractor or the horsepower required by an implement. To find the horsepower, set a straight edge on the pounds pull and the speed in miles per hour and read directly the horsepower, or set on the dynamometer reading and the time in seconds and read directly the horsepower being developed.

The development of this nomographic chart is quite simple. The original horsepower equation is $HP = (F \times D)/33{,}000$, where F is the force or pounds pull and D is the distance in feet traveled per minute. It is usually more convenient to measure the time in seconds; therefore, the equation becomes $HP = (F \times D)/(t \times 550)$.

When using the Iowa dynamometer the distance is always 50 feet, measured automatically. When the distance is 50 feet, the equation becomes $HP = (F \times 50)/(t \times 550)$, which reduces to $HP = F/(t \times 11)$, which may be changed to $HP \times 11 = F/t$. By the use of logarithms this last equation becomes $\log HP + \log 11 = \log F - \log t$.

We turn to the determinant method for a solution and we can say, in general, that if a three-variable equation can be arranged in all nine squares of a third order determinant, with the intersection of suitable constants, including unity and zero so as to make the resultant value equal to zero, there is an alignment chart corresponding to the original equation. Since the general determinant can be brought into the reduced form by a great variety of processes, each will result in a different chart. The designer must pick out the particular form that will best suit his equation and the limits with which its variables must be read.

Placing the equation in the determinant form, we have

$$\begin{vmatrix} -1 & \operatorname{Log} F & 1 \\ +1 & -\operatorname{Log} t & 1 \\ 0 & (\tfrac{1}{2}\operatorname{Log} HP = \operatorname{Log} 11) & 1 \end{vmatrix} = 0$$

This symbol may be evaluated by mathematical process and it reduces to the original equation, $\operatorname{Log} HP + \operatorname{Log} 11 = \operatorname{Log} F - \log t$.

Let $x = -1$, and plot y as $\operatorname{Log} F$; and then let $x = +1$, and plot y as $-\operatorname{Log} t$. Then when $x = 0$, y plots as $\tfrac{1}{2}$ ($\operatorname{Log} HP + \operatorname{Log} 11$). This nomograph plots as three parallel lines and is known as the parallel type diagram. In order to permit the most accurate location of the isapleth, the third variable on the middle line should be the unknown quantity in the equation.

Author: Instructor in agricultural engineering, Kansas State College. Assoc. Mem. ASAE.

In plotting Fig 1,

Let $x = -1$. Y is plotted as $\log F$ with the limits 320 to 2000 pounds.

Let $x = +1$. Y is plotted as $-\log t$ with the limits of 5 to 31, which is approximately 1 to 7 miles per hour.

Let $x = 0$. Y is plotted as $\tfrac{1}{2}$ ($\log HP + \log 11$) with the limits of 1 to 35 horsepower.

Fig 2 is obtained by rotating the x axis until the three columns are nearly even and would plot on a sheet nicely. By multiplying both the horizontal and vertical distances, a chart of any convenient size can be made.

When using the Iowa dynamometer, just two things are recorded—the dynamometer reading and the time for the 50-foot test.

There is a straight-line relationship between pounds pull and dynamometer reading, so the pounds pull may be plotted on one side of the left line, and by calibration the dynamometer reading can be plotted on the other side of the same line. There is also a straight-line relationship between the time in seconds for the 50-foot test and the speed in miles per hour, so either speed in miles per hour or time in seconds may be plotted as one side of the right line, and by calculations the other side may be plotted. With these three lines the dynamometer reading can be converted directly into pounds pull, the time in seconds can be converted into speed in miles per hour, and by use of a straight edge the horsepower for the dynamometer reading and the time in seconds can be read directly. Thus we can read directly the three things in which we are interested—the horsepower, the pounds pull, and the speed in miles per hour.

This nomographic chart can be used for any Iowa dynamometer, but it will be necessary to calibrate each machine and replot the dynamometer reading to agree with the pounds pull. Also, if the instrument is much used, it is good practice to recalibrate it to check the accuracy of the dynamometer reading with the pounds pull.

The chart can also be used for any dynamometer when the distance for the test is 50 feet. If it is the direct-reading

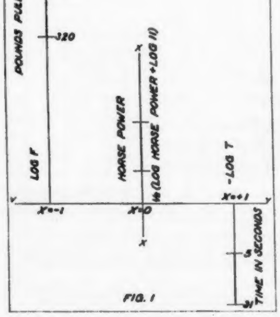


FIG. 1

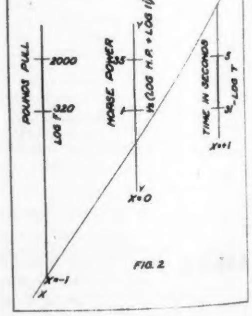
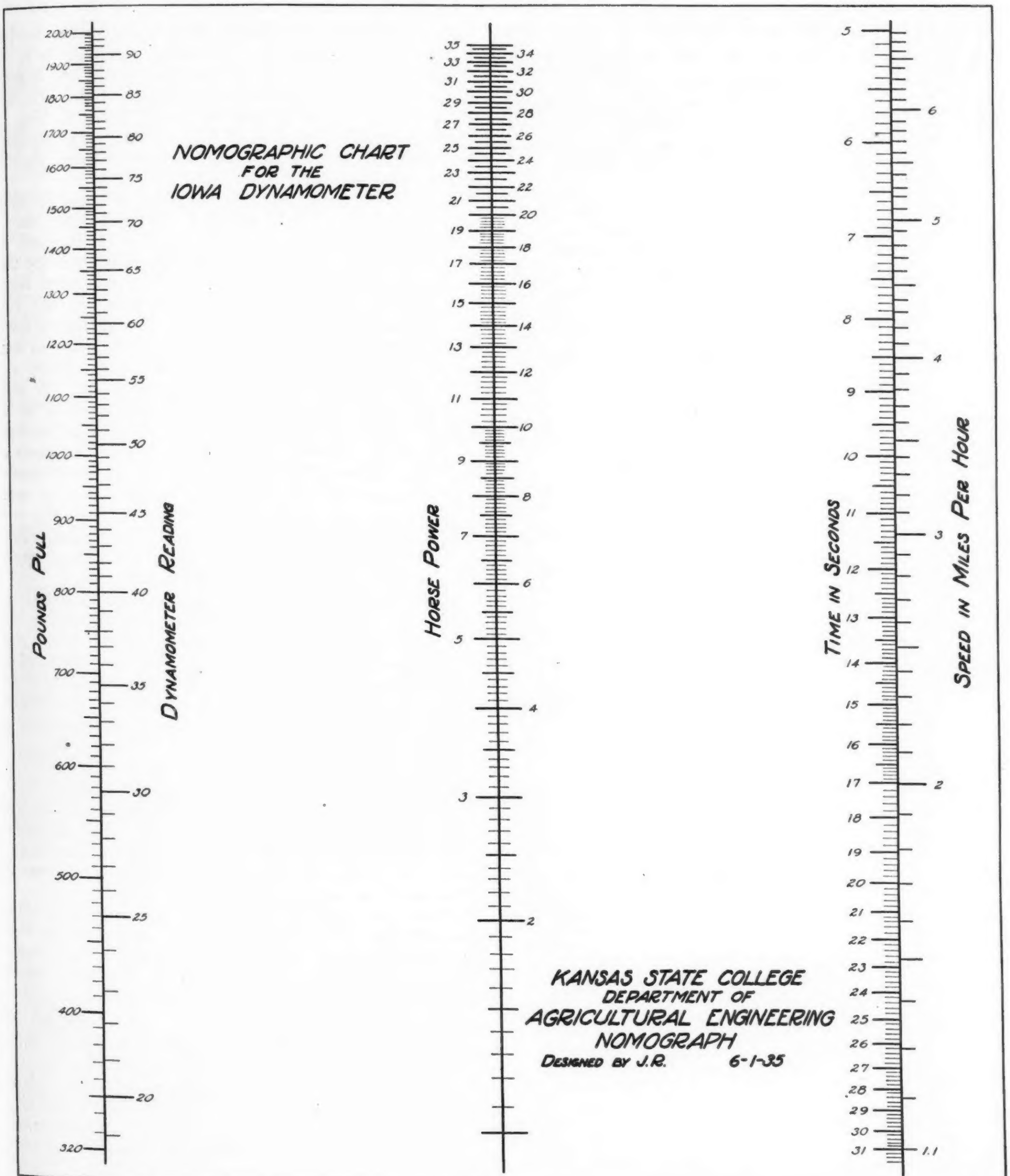


FIG. 2

type, so much the better, but if it is of the indirect reading type, then it will be necessary to calibrate and plot the dynamometer reading to agree with the pounds pull. The chart can also be used for any dynamometer when the pounds pull and the speed in miles per hour are known.

This chart is especially valuable for field work, and by it we can convert dynamometer reading into pounds pull and time in seconds into miles per hour, or miles per hour into time in seconds. Both the pounds pull and the time in seconds can be converted into their horsepower value.



THIS NOMOGRAPHIC CHART FOR THE IOWA DYNAMOMETER WAS DESIGNED BY JUNE ROBERTS, INSTRUCTOR IN AGRICULTURAL ENGINEERING, KANSAS STATE COLLEGE. THE CHART IS ESPECIALLY VALUABLE FOR FIELD WORK

Some Farm Machinery Developments Observed in Europe

By G. W. McCuen

WE VISITED seven countries in Europe this summer (1935) and had an opportunity to observe all of them at work in both the factory and on the farm. The two countries which impressed us most were England and Germany. Although we traveled nearly 1800 miles in France, we did not observe as much evidence of progress as we did in the two countries just mentioned.

England is apparently on the way out of the depression, which has been as bothersome there as it has been with our own country. There is a general revival in the agricultural implement industry as well as an interest in the welfare of the farmer. The English farmer has a ready market for his product at home. England is only one-thirty-eighth the size of the United States and has a population of 46,000,000. When industry is at all on the up grade, the farmer finds a ready market for his products.

England impresses one with the beauty of its countryside. We found the English farm home hospitable and the farmers especially eager to discuss their machinery and equipment problems.

As previously stated, the manufacturing of agricultural implements was quite active and nearly up to the high production level of the post-war period. This was especially true in the larger units such as the heavy power tools, threshers, and allied heavy equipment.

It will be necessary to confine the discussion of our observations to the unusual equipment, that is, equipment which is quite different from that manufactured or used in America.

Grass Harrow. The South Devonshire area of England is devoted to large acreages of grass, which, if not cultivated, becomes badly choked with moss, which forms quite readily on certain soils, and its growth or spread is enhanced by the damp weather of that section of the country. This "weed," as we might call it, must be removed each spring or early summer. There are several methods of raking or cultivating the grass, but the outstanding one was produced by Gibbs and Company, Crewskerne. It was called the "cake walk" self-cleaning grassland harrow. It consisted of tines arranged 2½ inches apart in two sections, spaced about 3½ feet apart. These tine bars are mounted in front of each other, and as the machine moves forward the tine bars rise and fall alternately, one tine bar cleaning itself while the other is working. Continuous harrowing is insured and no ground left uncultivated. It cleans itself every 12 feet.

Storage and Stacking. The average English farmer does not have large storage space on his farm, so stacking as resorted to as a means of storing either hay or bound grain. It was observed that these stacks were of unusual height, that is, for the material to be pitched up. It was not until one noon that we found out how these large, high stacks were built. They use a stacker similar to the straight stacker on a threshing machine. It is an independent unit mounted on transport trucks and is generally operated by a small petrol engine. If this unit did not adapt itself so admirably for bundle grain stacking, it would be hard to conceive of its economic use in stacking hay, for it seemed to me there were much more efficient ways of stacking hay.

One of the machines that is talked of most in England, especially on large farms, is the gyro tiller, manufactured by John Fowler & Company, at Leeds, which is well accepted as an economical soil-preparing unit by the majority of the larger operators who grow sugar beets and potatoes. It does not, in a sense, plow the soil, but just stirs it up to a depth of about 14 to 18 inches, leaving the ground practically with the same stratification that it had before going over it with the tiller. There are three sizes of this machine manufactured—30, 80, and 170 hp, each of these machines being operated by a Diesel engine. Electric starting and lighting is standard equipment so that the machines can be used 24 hours a day. The tillers which do the work are fashioned somewhat like the dolly of a dolly-type washing machine, each dolly carrying six tines which revolve at about the rate of 60 revolutions per minute, and the tractor moves forward at three different rates of speed, the average speed being slightly better than a mile per hour.

One of these machines was seen in operation and an opportunity was had to talk to the man for whom the work was being done. This particular gentleman was quite enthusiastic over the results obtained from using the gyro tiller. It cost him 30 shillings an acre, or $7.50 in American money, to have the field tilled. He claimed that they were able to get better beets and potatoes as a result of this deep tillage. He was positive in his statements that even at the high cost of preparation it was a paying proposition. In another section of England I got a little different opinion, namely, that the soil would run together if there were many heavy rains, and of course a heavy rain in England similar to what we have is unusual. Their rains fall rather slowly, and with this method of tilling all of the water is readily absorbed.

When one considers that the large size rotary tiller costs 6,500 pounds sterling, it can be easily seen that with this investment the operator must make a very heavy charge for his work. It is my opinion that there would be very little use for a similar machine in America.

English Combining. England has not been able to successfully use our system of combine harvesting their grain, so they have developed a system under the Hornsby patents which seems to meet the general conditions in that country. The weather in England is not at all conducive to the use of the combine, due to the fact that in normal seasons there is a small precipitation falling at frequent intervals.

The Hornsby system, which seems to meet with the approval of the Englishmen, is one in which the grain is cut with a device similar to our binders without a binding attachment and the unbound grain delivered by elevator to a wagon drawn alongside. This grain is then

---

Presented before the Power and Machinery Division of the American Society of Agricultural Engineers, at Chicago, December 2, 1935.

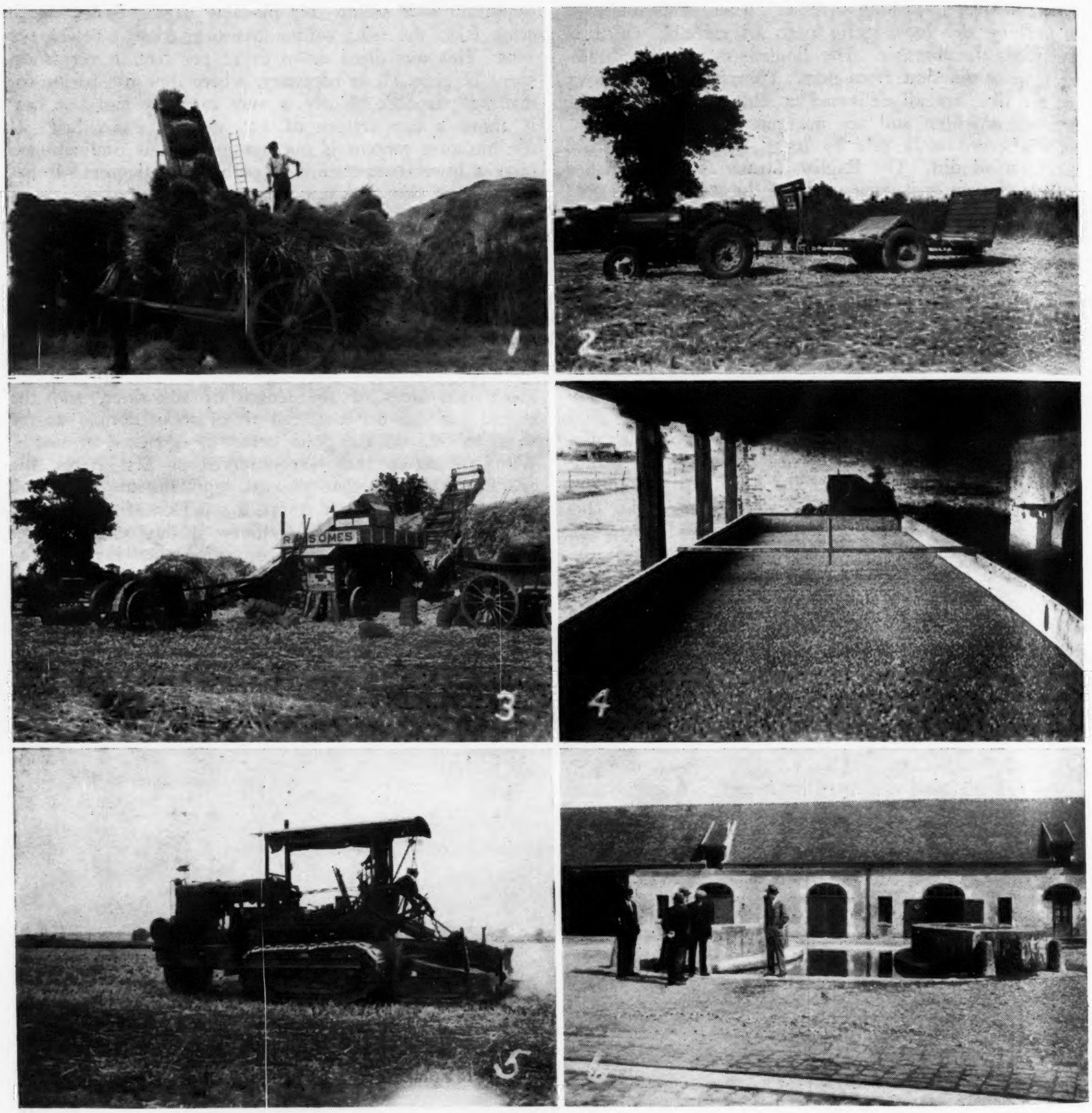
Author: Professor of agricultural engineering, Ohio State University. Mem. ASAE.

hauled to their "finishing thresher" where it is unloaded by pitching the loose grain onto an elevator which in turn feeds the thresher. The English method of threshing is quite different from ours. The chaff, short straws, and the like, are all delivered at different points in the threshing machine and are not put in with the straw, but discharged in a pile by itself. The straw is then free from all dirt. The English farmer is quite satisfied with this system as it does not leave the straw on the field which he desires for bedding purposes. Also it is not such a radical departure from the system which he has been used to over a period of years.

Due to the humid climate in England, the grain and hay drier is meeting with a great deal of success. We had the opportunity to visit a farm that was using the combine harvester system just mentioned, together with the grain drier. This was on the East Acre Farms, at Kings Lynn, which is in the northeastern section of England. This is a rather large farm which has about 900 acres in barley and wheat and about 2050 acres in alfalfa. The Ransomes, Simms and Jeffries Company are manufacturing a drying plant under the Davies patents under licenses granted by the British Crop Driers, Ltd. This equipment is very simple in construction and operation. It consists of a traveling perforated belt on which the hay or grain is placed, and the entire products of combustion are forced through the mat of hay or bed of grain, and the moisture is removed in a relatively short period. Coke is used as a fuel. With only a few changes the drier can be used for drying grain or hay. I had the opportunity of seeing this machine drying barley which came from the field with a moisture content of 21 per cent. This was dried down to 12 per cent in very short space of time. It is necessary, where they use barley for malting purposes, to dry it very carefully and not heat it above a temperature of 125 degrees Fahrenheit. If the moisture content is not too great, it is preferable to carry a lower temperature of perhaps 90 degrees. It has been found that they can use a maximum temperature of 135 degrees for oats and even as high as 180 degrees for wheat. The mat of grain and hay on the drier will vary from $2\frac{1}{2}$ to 5 inches in depth, depending upon the amount of moisture in the grain. A low velocity of air is used. The drier is about 30 feet long, 7 feet wide, and 3 feet, 6 inches high. It is a very compact unit, consisting of the drier unit and fans for the circulating air. The first fan discharges the high temperature air through about two-thirds of the length of the drier, and the second fan delivers tempered air of about normal degree so as to cool off the grain before it is sacked or stored. With the set-up that was observed at East Acres, the operator was more than pleased, especially on barley and alfalfa. They had three driers, a small one for grain and two large ones for drying alfalfa. I was unable to get any figures on the cost of operation, but inasmuch as these driers have been used for a period of three years and the users are well satisfied, it seems to indicate that the machines are practical. Several others were located in the immediate community and were used cooperatively.

Potato Diggers. The potato diggers in England and

(1) LUNCH IN A BLACK FOREST (GERMANY) FARM HOME. LEFT TO RIGHT, MRS. G. W. MCCUEN, J. B. DAVIDSON, MR. MCCUEN, AND HERR WEBBER. (2) AT THE TRACTOR TESTING LABORATORY (BERLIN). LEFT TO RIGHT, ASSISTANT TO PROF. MYERS, PROF. MYERS, PROF. MCCUEN, DR. DENCKER, AND DR. TROESCHER. (3) THRESHING WITH ELECTRICITY IN GERMANY. (4) A HOMEMADE TRACTOR IN GERMANY



(1) STACKING WHEAT IN ENGLAND. (2) AN ENGLISH BUNDLE RACK AND TRACTOR. (3) A THRESHING SCENE IN ENGLAND. (4) DRYING THRESHED BARLEY IN ENGLAND. (5) THE GYRO TILLER IN USE IN ENGLAND. (6) AN ANIMAL FOOT BATH IN FRANCE

on the continent are quite different from the American patents. I found that, for some reason, the belt type digger was not accepted as a rule. Two distinct systems, different from any American type, were used, one being the spinner which literally threw potatoes, debris, et cetera, to one side, leaving the potatoes on the surface and the operation of gathering up made easier. The other is known as the tine or forking machine. This patent had a large knife lifter which ran underneath the potato hills and loosened the ridge. This action was followed by rotating forks which ran parallel to the axis of the lifter. The potatoes and dirt were thrown to one side where they could be picked up easily. The forks on this machine were operated something like the forks of a hay tedder, although moving crosswise of the line of travel instead of in the line of travel.

German Agriculture. When we arrived in Germany we found that the farmers there had never been prejudiced against the machines, in spite of the fact that officials and press were very much opposed to machinery in agriculture. Much propaganda, similar to what the United States experienced in the depth of the depression, had been broadcast. But just as soon as the German farmers began to get a little money in reserve, they started buying machines in greater numbers than in any previous period. In August all German factories manufacturing farm equipment were running, in nearly all instances, at full capacity.

The general-purpose tractor, as we know it in the United States, is not accepted in Europe. They are interested, however, in the small type tractor. The reason for their not being interested in the general-purpose type

tractor is the fact that very few row crops are grown in Germany outside of sugar beets. They are, however, interested in mechanical power in the form of small tractor.

One of the interesting developments that have been worked out in Germany is the small tractor capable of pulling one plow. That type of tractor, of which we saw several, was a rather crude affair. The motor being either a small, two-cylinder unit, or a single-cylinder, oil-burning engine similar to our regular farm engine. They had a full complement of equipment worked out for these small jobs which included a mower cutter-bar attachment for the tractor. The reason that the German farmer is interested in this small, lightweight tractor is due to the fact that Germany as a nation is only 85 per cent self-sustaining as to food products. If the small tractor can be successfully adapted to the agriculture of Germany, it will then be possible for them to convert the feed, which would be normally used for feeding work animals, into food for human consumption. The government is very much interested in this particular phase of German agriculture, which is evidenced by a liberal support in research in the small tractor development.

We spent some time at the Rudolph Sack factory at Liepsig. When we visited this factory we were very much impressed with the progressive methods employed. Dr. Hans Sack, who is a member of our Society, was very kind and showed us through the factory himself. He took pains to explain to us all the different processes used.

Tractors being used for transportation was a fact that impressed us greatly. To meet the transportation needs, the Hans Sack Company has developed a very high-class wagon which may be used either on the farm or on the road. It was equipped with high-grade, taper roller bearings of American make, together with a complete complement of brakes. The front truck of the wagon was very substantially built and was so designed as to give quick turning effect. The chassis of this wagon was so constructed that almost any type of body, from the flat rack to the wagon bed, could be easily installed. They were producing about thirty of these wagons per week and were finding a very ready market for them.

TRACTOR PLOWS OF GERMAN MANUFACTURE PROVED TO BE QUITE SIMILAR IN DESIGN TO AMERICAN PLOWS

The Sack Plow Works. When we visited the plow factory of this company, we found that many of their tractor plows were quite similar in design to American products. This company seemed to be rather proud of the plow shares that they had developed and had a rather unique way of trade-marking these shares. They used three colors of varnish on them; the cutting edge had a straw-colored varnish; the midsection was covered with a red varnish, and the top edge, about 1-inch in width, had a blue varnish. This was to indicate through the colors that this was a piece of heat-treated steel, and the farmer who purchased the share could know that he was getting a high quality product.

The Grain Drill Factory. The seeding machine factory, in which they manufactured grain drills, was also very interesting. The general design of the drill is similar to our American drills with this exception; it was equipped with a forecarriage which had a long tiller lever which could be set for guiding the drill when the operator rode on the foot board of the drill or to either the right or left of the drill in case the operator wished to walk. Upon inquiring why they had this type of forecarriage, I learned that the German farmer wishes to plant his small grains in very straight rows so that the crop can be cultivated. The German farmer feels that a wheat crop, when cultivated, produces a much better quality wheat than one that is allowed to grow without cultivation.

Drill Calibration on the Farm. Provisions are made so that a farmer can calibrate his drill for the grain he wishes to sow. This is accomplished in a very easy way as follows: A galvanized sheet metal box is furnished which can be placed under the delivery tubes so that the drill can be calibrated by turning the main drivewheel a certain number of turns. The different sizes of seeds in the different provinces makes this feature necessary. The fine adjustments for the rate of seeding made it possible to get the exact amount of seed through each furrow opener as required. Instead of using the standard cast iron, fluted feed, we found that they were using a hard-rubber fluted feed. This, they said, was less damaging to the grain sown. Great accuracy was claimed for these drills.

Wheat Cultivating Harrow. For cultivation of wheat the Rudolph Sack people had developed a flexible harrow called "Unkrauestriegel." Considerable time and effort had been spent in the development of this harrow to get the right weight so that in cultivation the wheat plant would not be injured, yet small weeds would be destroyed.

LARGE PERCENTAGE OF GERMAN-BUILT TRACTORS ARE USING LOW-PRESSURE PNEUMATIC TIRES

German Tractor Factory. When we visited the Lanz factory at Manheim, we were impressed with the size of the factory and also the activity in production. They employed about 5,000 men in the production of tractors, threshing machines, and hay balers, and a general farm tool. The Lanz tractor, with which the majority of you are probably familiar, is a single-cylinder, semi-Diesel job. This tractor seems to be very well accepted by the German farmer as well as the export trade in other countries in Europe. It burns a low-grade of fuel quite successfully and seems to give but very little trouble and has an extremely low up-keep. A part of our inspection trip through this factory took us to the loading platform. We found there that a large number of tractors were being driven away under their own power. These tractors were mounted on rubber tires. Seventy per cent of the tractors manufactured by this company were used for agricultural purposes, and 30 per cent were equipped with rubber tires for the industries other than agriculture. Their production for the year 1935 was 4,000 units.

German Threshers. The threshing machine manufactured in Germany by this company is very similar to those manufactured in England. Each thresher is an individual production. The crew assembled one machine from start to finish. It is not the progressive system as used in the United States. However, to meet the demands of the trade, they have forty-five different sizes of threshers, so it can be readily seen that with this great number of sizes and types, it would be hard to use a progressive system of building the machines. Their output for the year was 2,000 units.

Hay Balers. During the period when the farmers were buying but a very small amount of machinery, development had steadily gone on and the hay baler which they are now producing is a very high-grade product. The baler is used largely in connection with the threshing machine, baling the straw as it is delivered from the thresher.

We found that in practically all construction where steel was utilized, electric welding was used very extensively.

Rubber Tires for Tractors. I have mentioned the use of rubber tires on farm tractors in Germany. Doctor C. H. Dencker whom you will recall visited this country in 1931,

has charge of the tractor testing laboratory at Berlin and is in very close touch with the industry. He mentioned this fact which I am quoting: "The rubber tire for the farm tractor has been one of the most significant developments that has happened in the past ten years." The findings in Germany have been very comparable to the findings in America with reference to rubber tires on tractors. In England the rubber-tired tractor has not met with the success that it has in America and Germany due to the fact that the showers which occur very frequently, yet are not heavy enough for the farmer to have to quit work, makes it somewhat impractical to use rubber-tired equipment there without chains. However, the English farmer is turning very rapidly to the use of rubber tires on drawn equipment, especially the two-wheeled wagons. They, too, have found that the rolling resistance of a wagon when equipped with rubber tires is much less than one equipped with steel. We found rubber tires on wagons used quite extensively.

The last factory that we visited in Germany was that of the International Harvester Company in Neuss-am-Rhine. We were very much impressed with this factory as it had combined two outstanding features—American efficiency in production, together with the German orderliness. The malleable casting of this company I believe can be said to be the most efficient one in Germany, and I am not sure but what we might say in the world. The malleables produced in this factory are very high grade. It seemed like getting back home when we visited this factory for we were able to use the English language very extensively, as practically all the foremen and superintendents spoke English. We probably did more visiting here than we did inspecting. As we visited the show room we again felt that we were back home for the products there bore names with which we were very familiar. The binders which are used in Europe and England are very similar in design, with the exception of the deck which was much longer due to the fact that the grain grown on the British Isles and on the continent is much taller and all of the straw is saved. The tying apparatus, too, is much heavier due to the extra work it has to perform. All of the tractor binders were so constructed that the gears, which were exposed to dust and dirt, were encased and run in a bath of oil.

Very little machinery of any sort is used in Switzerland due to the fact that the topography is very rough and only in limited areas can any modern machinery be used at all.

SPANISH AGRICULTURE HAS NOT ACCEPTED MODERN MACHINERY AS HAVE OTHER EUROPEAN COUNTRIES

Spanish Agriculture. Spain is a country that is quite different, agriculturally, from any of the other sections of Europe which we visited. The land is rather poor and the farmer has not accepted modern machinery as a group. Sixty per cent of the total population in Spain is engaged in the pursuit of agriculture, and if agricultural machinery were used extensively in Spain, it would seriously affect the unemployment situation, as there is little industry to absorb labor if it were released from agriculture. The Spanish government, in March 1934, issued an edict that 50 per cent of the agricultural work must be done by hand labor. For example, in the olive industry the olive grader has been dispensed with, for by using it 10 women and 1 man were able to do in ten hours what 48 women and 3 men could do without the use of a grader. Therefore, machinery in all phases of Spanish agriculture has received a serious handicap. We were impressed and surprised at the type of tools used on the smaller as well as on the larger and more modern farms. The Roman plow, a wooden plow with a steel point, is widely used, and is drawn by one mule or horse. A very large percentage of the grain is threshed by means of the mule, ox or donkey tramping it out on the threshing floor and later cleaned by winnowing. In the southern part of Spain we found American machinery accepted to some degree. It was found and used on the better farms. Even in road building work we found that very little of the up-to-date equipment is used due to the fact that they have so many people that must be employed. Labor and mules are cheap. One of the chief criticisms that we as Americans received in Spain was to us rather amusing, for they said that in American agriculture there is no peasant class and therefore the agricultural situation in the United States would be much harder to control than in Spain. It is my sincere hope that the American farmer will never become the peasant type we saw in Europe.

TREMENDOUS IMPETUS IS BEING GIVEN TO RURAL ELECTRIFICATION IN EUROPEAN COUNTRIES

Rural Electrification. We found in practically all countries of Europe that a tremendous impetus was being given to the distribution and utilization of electricity. Although England has but a small percentage of her farmers as a whole using electricity, we found that the government was spending an enormous sum of money in an endeavor to bring about a more satisfactory distribution in the country. We found that one of the big problems in England was to first bring about a standardization of voltages, as there are several different standards of voltage in England. We were informed that in Germany 95 per cent of those classified as farmers have electricity. However, they are not using it as extensively as the American farmers who have electricity are using it. The reason for this great distribution in Germany was the fact that German farmers live in villages and also that the tractors followed the distribution of electricity, while in America the tractor preceded the distribution of electricity, and power on the farm was not an unknown thing. In the better farming area in Switzerland we found electricity used almost universally, and in Spain the development of the use of electricity was the most pronounced of all their industrial developments, if we classify electricity as an industry. France is going forward in the distribution of electricity, but, unfortunately, due to the language barrier, we were unable to get any statistics in this phase. It was in France that we learned that American agricultural machinery was more generally accepted due to the fact that it (expressed in words of a Frenchman) is always two jumps ahead in its development and is better adapted to the French needs. We did not find the same flourishing condition of agricultural machinery manufacturing and use in France that we found in the other countries. It is apparent that the depression in France had lagged behind the depressions in other countries. Business was good in France during the depression periods in the other countries, but today the agricultural machinery trade is not up to normal. Very little new machinery is being purchased by French farmers, except for replacements, and no expansion in greater use is being made. This has been true for the years 1934 and 1935.

Our travels through England, Belgium, Holland, Germany, Spain, and France were accomplished through the convenience of the automobile. This made it possible for us to see agriculture as we would not have been able to see it had we travelled by bus and train. In all, we travelled over 7,600 miles, making these observations. We received the most courteous treatment in all countries, and at the majority of places we visited we found them eager to give us all the information desired. We cannot help but feel that the courteous treatment received in all of these countries reflected a kindly feeling towards America.

Farm Equipment Research and Testing Stations in Europe

By J. Brownlee Davidson

THE AUTHOR, in company with Professor G. W. McCuen of Ohio State University, visited during the summer of 1935 a number of research or testing stations for farm equipment in Germany, France, England, and Spain. This paper is not intended to be an exhaustive or complete review of all the public research or testing institutions in Europe, but rather it is an account of some personal observations made while visiting a number of institutions in the countries mentioned. It should be explained that there are active institutions in a number of other countries, particularly in Denmark, and the USSR.

Germany has the most extensive program for research in farm equipment of any European country. One of the first impressions obtained in contact with the German institutions is that the work of the public institutions and the interests of the manufacturers and farmers are especially well coordinated. All of the institutions are organized under the Reichskuratorium fur Technik in der Landwirtschaft, commonly called the RKTL. This national bureau or council for agricultural engineering was formed by the Ministry of Food and Agriculture and has for its purpose the promotion of agricultural engineering science and technique. The RKTL is not itself a research institution. It is a coordinating, organizing, financing, and information disseminating body. It acts as a clearing house for all activities. That it is a very active organization in the furnishing of information is indicated by the number of publications which have been issued since its organization. Those of the regular series of publication, which includes volumes of considerable size, are listed in the 1934 annual report up to No. 64. The subjects treated include not only farm equipment topics, but also management, economics, and transportation. These publications are particularly high grade, being thorough and complete.

Perhaps the most significant activity of the RKTL is bringing about what would appear to be complete coordination of the research work throughout the entire German nation. Research in agricultural engineering is conducted to some extent at more than twenty-five institutions, yet there is little duplication because there has been an allotment of problems among the institutions. It is clear that this coordination has made for increased economy and efficiency.

The researches conducted in this coordinated plan are at least in part financed by grants from the Ministry of Food and Agriculture. We were told that these grants were on the annual basis. This being true, it would seem that the unproductive institutions would not expect to be supported long. The stability of German educational institutions, on the other hand, should furnish adequate protection against the depressing influence of uncertain support.

Two of the research institutions in Berlin were visited. Both of these institutions appear to be affiliated with the Landmaschinen-Institut der Landwirtschaftlichen Hochschule, University of Berlin, under the direction of Dr. C. H. Dencker who visited the United States in 1931. The laboratories are not located at the central grounds of the University, but that for farm machines under Dr. Kloth has assigned for its use a group of buildings in the city of Berlin, and that for tractor research is located near Potsdam under the immediate direction of a Mr. Meyer.

At the farm machine laboratory much attention is given to the study of materials which enter into the construction of farm machines. An effort has been made to standardize plow shares. It was pointed out that a soft untreated steel share has a life of 85 hours under certain severe conditions, while the life of a hardened share is 220 hours under the same conditions. The smaller manufacturers, we were told, at first objected to the efforts to standardize quality, but now they look to the institute to give technical laboratory service in the checking of materials which they have not previously been able to provide for themselves.

Some very ingenious and original machines were observed for the testing of the resistance to abrasion. Not being a metallurgical expert, I am not able to judge the merits of the equipment, but it would seem that the work done with materials was of an advanced order, thorough and up-to-date. Tests were under way of binder twine and various other products and materials. Milk cans were being tested by technique not different in principle from the durability tests practiced by our automobile manufacturers.

Elaborate studies of certain farm machines were under way. The one that attracted my attention in particular was a kinematic, friction, and inertia study of the mower. This particular set-up for experimental work was especially elaborate and thorough.

Extensive studies were under way of hand tools, such as spades, shovels, and axes.

At the tractor testing laboratory three testing tracks of clay, clay and cinders mixed, and cinders, respectively, shops, storage buildings, and an office building were found. The dynamometer car used is in principle like that used at Nebraska. In fact, the testing technique seemed to be quite similar to that used at the University of Nebraska and approved by the American Society of Agricultural Engineers.

It is now the practice in Germany to submit the new models of tractors to test before they are placed upon the market. Although apparently not compulsory, it is practically impossible because of the relation of the RKTL to the farm organizations, to sell a tractor in the country without first being tested. There is much interest at the present time in heavy fuels for tractors. This may be understood when the difference in the price of the fuels is pointed out. We were told that gasoline sold for 50f per kilogram, kerosene for 20f, and gas oil for 14f. The economy of the Diesel and semi-Diesel engines commands special attention on account of the lower price of the heavy fuel.

Much interest was manifested in the small tractor of 8 to 10 horsepower. Bulletin No. 42 of the RKTL by Dr. Dencker and Mr. Ries is entitled "The Importance and Possible Development of the Small Tractor on the Peasant Farm." The arguments for this type of tractor are its lower first cost and greater annual use.

Presented before the Power and Machinery Division of the American Society of Agricultural Engineers, at Chicago, December 2, 1935.

Author: Professor of agricultural engineering, Iowa State College. Charter ASAE.

At the tractor station experiments in trailer carts and wagons were being conducted. One very interesting demonstration we saw was the use of a cart which transferred a part of the load to a tractor with pneumatic tires increasing its resourcefulness in soft fields.

At the University of Munich we found a splendidly equipped laboratory with research under way on a wood-burning gas producer, grain graders and cleaners, and tillage machines. This laboratory was particularly well appointed in every respect. A soil groove for the study of tillage machines was a part of the laboratory, with a car capable of being operated at a wide range of speed, for measuring the resistance of the tillage machines.

A wood-burning gas producer was under test. It seemed to be operating successfully, giving a horsepower-hour for about 1 kilogram of fuel. The wood was cut into small blocks about 2x2x4 inches in size.

At the University of Bonn the research work is under the direction of Dr. Vormfelde. This station is committed with studies on harvesting, threshing, and baling machines. Special machines for viticulture are also given careful study.

This station has been experimenting with a new type of combined harvester-thresher which threshes the grain in a vertical position and after threshing leaves the straw in bound bundles.

A visit to two of the leading farm machine factories in Germany convinced us that there was a very fine relationship and effective cooperation between the public and commercial institutions of Germany. Evidently an understanding has been arrived at as to what constitutes mutual interests and a working program for cooperation decided upon.

Before visiting France, arrangements were made to visit the Central Agricultural Machinery Testing Station under the Ministry of Agriculture. This station has offices and laboratories in Paris and is directed by Prof. Tony Ballu. The institution undertakes a wide range of studies. One of the principal activities is a study of the physical-mechanical characteristics of the soil with special reference to tractive efficiency. Special apparatus has been designed to measure the physical characteristics such as compressibility, shearing resistance, and plasticity of the soil in the field. Other apparatus measures the action of the tractor lug in the soil. Apparently this work has not progressed far enough for the publication of results.

Spraying and dusting machines are given considerable attention, but no active work was under way along this line when we visited the station.

This central station in France issues official certificates to manufacturers of machines. Apparently these certificates are not necessary for the sale of a machine in the country, but do indicate approval and are an aid in selling. One manufacturer suggested that they were not difficult to secure.

The station sponsors tractor demonstrations and such a demonstration was scheduled for the last week in September.

We also visited the National College of Agriculture at Grignon, northwest of Paris. Little experimental work is conducted at the college, although instruction in agricultural engineering subjects is included in the curriculum.

Some research in problems related to agricultural engineering is carried out at the Central National Experiment Station of Grignon where agricultural research of a general character is conducted. The annual report of the station for 1934 gives data on the cost and practicability of tractor and electric motor power.

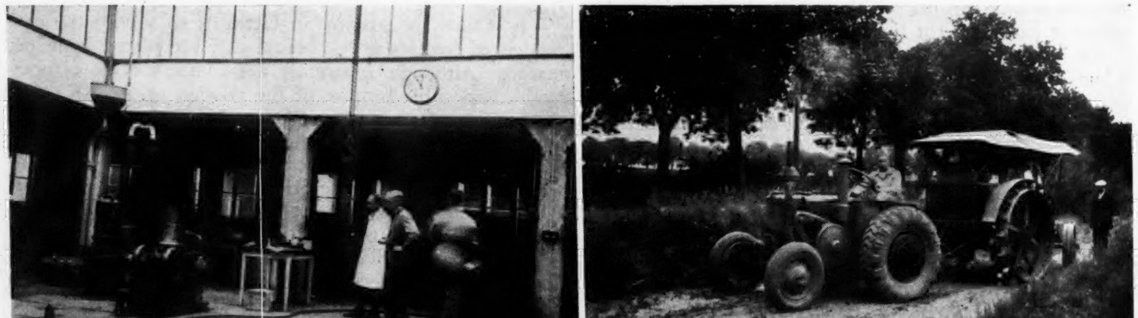
These power studies were begun in 1926 and have been continued to date. The tractor used is a Latil and the electric outfit is of the windlass and cable type. No definite conclusions have been published that we could find but considerable data are available. The operation of the electric outfit has been in the hands of a Society of Electro-Motorculture which conducts the work required of it on a contract basis. A schedule of prices is furnished, including plowing 20 to 22 centimeters deep at 200 francs per hectare, to plowing 28 to 30 centimeters deep, plus subsoiling 10 centimeters, at 350 francs per hectare.

It appeared to us that there was very little cooperation between the French institutions and the manufacturers. Certainly the teamwork found elsewhere did not prevail.

In Great Britain research in agricultural engineering is centered in the Institute for Research in Agricultural Engineering at Oxford University. This institute undertakes the study of all kinds of agricultural engineering problems, including drainage.

Agricultural research in Great Britain has been allotted between the various institutions, somewhat as follows: Cambridge University, research in plant breeding and animal nutrition; Oxford University, research in economics and agricultural engineering; University of Reading, research in dairying; and University of Bristol, research in cider, etc.

Little research in agricultural engineering is therefore found outside of Oxford. The Rothamstead Experiment Station for Soil Science, the oldest *(Continued on page 84)*



(LEFT) THIS PICTURE SHOWS THE TEST OF A WOOD-BURNING, GAS PRODUCER PLANT AT THE INSTITUT FUR LANDMASCHINEN AN DER TECHNISCHEN HOCHSCHULE, DR. G. KUHNE (MEM. ASAE), DIRECTOR. (RIGHT) A DYNAMOMETER CAR AT THE TRACTOR TESTING STATION OF THE LANDMASCHINEN-INSTITUT DE LANDWIRTSCHAFTLICHEN HOCHSCHULE, DR. C. H. DENCKER (MEM. ASAE), DIRECTOR

The Bureau of Agricultural Engineering

THE Bureau of Agricultural Engineering (USDA) welcomes the opportunity of presenting its work to the members of the American Society of Agricultural Engineers. It is proposed in this article to cover the general organizations of the Bureau and to give a little of the background for the descriptions of the current activities which will follow in later articles. It seems that the publication in some detail of the Bureau's plans for future projects and an informal presentation of the indications and trends shown in the progress of our research projects might be of considerable value to the profession. It should be possible in this way to at least indicate the results of investigations at a much earlier date than has been possible in the past.

Another purpose of these articles is to secure a better coordination and correlation of the work of the Bureau with that of other agencies, and this object can be obtained only through the cooperation and response of the readers. It is therefore hoped that the readers of AGRICULTURAL ENGINEERING will forward to the chief of the Bureau any comments, suggestions, or criticisms that they may have in connection with the material presented in these articles or concerning any phase of the Bureau's work.

The initial step in the development of the organization which is now the Bureau of Agricultural Engineering was taken in 1899 when Congress made an appropriation for irrigation investigations under the USDA Office of Experiment Stations. Dr. Elwood Mead (Hon. Mem., ASAE) was placed in charge of the early stages of the work, resigning in 1907. From the beginning the work in irrigation has been almost entirely research work, and at first was largely confined to studies of the duty of water, but the scope of the work was gradually increased as funds became available during the early years of the organization. In 1905 an appropriation was made for drainage investigations. In 1907 Dr. Samuel Fortier (Hon. Mem., ASAE) was placed in charge of irrigation investigations, and C. G. Elliot in charge of drainage investigations. The original drainage work included some research, but a large part of the work of the division consisted of giving active assistance, through the preparation of plans, to the organization of large drainage and flood protection enterprises. The work of these two divisions continued to grow in importance and the research work in the drainage division was increased and the amount of survey work was decreased. Mr. Elliott resigned in 1912 and S. H. McCrory (Mem. ASAE) was appointed chief of the division.

In 1915 the work of these two divisions was transferred to the Office of Public Roads and Rural Engineering, as was the machinery and structures work which previously had been carried on in the Office of Farm Management under the direction of E. B. McCormick (Mem. ASAE). In 1923 the three divisions were consolidated as the Division of Agricultural Engineering, Bureau of Public Roads. The field of activity was gradually expanded. In 1931 the Division of Agricultural Engineering became the Bureau of Agricultural Engineering, an independent unit in which the Chief of Bureau reports directly to the Secretary of Agriculture.

Research work on the engineering features of soil erosion control was begun by the division of drainage investigations about 1910 and continued in that division until April 1, 1935, when all soil erosion work was tranferred to the Soil Conservation Service.

Appropriations for agricultural engineering work increased gradually from the meager beginning to a minor peak in 1918, suffered a considerable decrease for a period of three years, and again increased gradually to a maximum of approximately $580,000 in 1932. Since that time there has been a considerable decrease in the funds available, but during the past two years the appropriations have been materially increased over the early depression period. The appropriation for the fiscal year 1936 is $423,269.

The accompanying chart shows the present organization of the Bureau, its various activities, and responsible personnel. The present staff of the Bureau, all of whom are under the Civil Service, consists of 85 engineers, 9 subprofessional draftsmen, 5 machinists, 39 clerks, editorial assistants, messengers, and laborers.

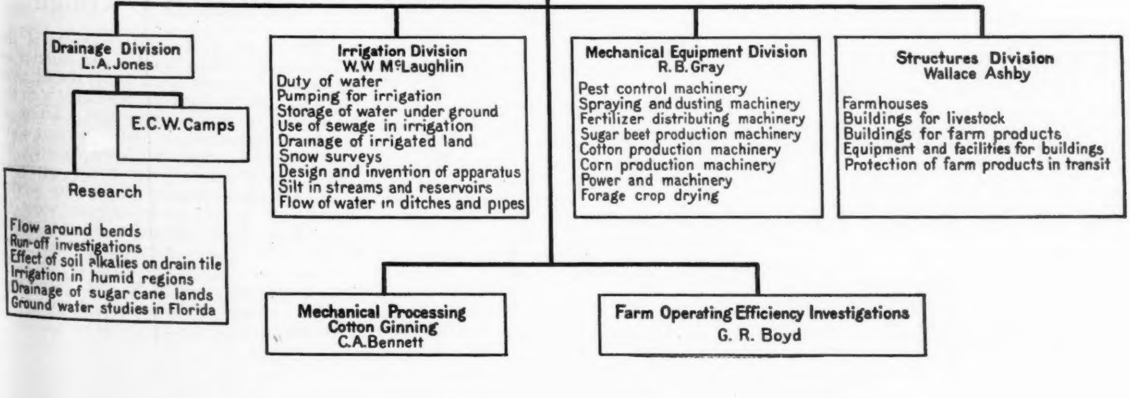
The Office of the Chief is responsible for administrative and technical control of the work, and for the determination and execution of the plans and policies of the Bureau.

The Administrative Division is responsible for the handling of all fiscal matters, personnel, purchasing, property, mail, and files.

The Editorial and Information Division has charge of the editing of manuscripts, reports and bulletins for publication.

The Library is a branch of the Department library and is maintained for the purpose of making works of reference on agricultural engineering subjects easily available to the members of *(Continued on page 81)*

ORGANIZATION CHART
BUREAU OF AGRICULTURAL ENGINEERING
U. S. DEPARTMENT OF AGRICULTURE



Elwood Mead

Dr. Elwood Mead, Commissioner of Reclamation in the U. S. Department of the Interior since 1924, passed away at his home in Washington, January 26.

Dr. Mead was an Honorary Member of the American Society of Agricultural Engineers, and early in December was unanimously elected by the Jury of Awards of the Society to receive the 1936 award of the Cyrus Hall McCormick Medal. Dr. Mead had been notified of his election as the McCormick medalist, and in acknowledging the honor conferred upon him he wrote "It means more because it is recognition of my special field."

Elwood Mead was born January 16, 1858, at Patriot, Indiana, of pioneer Hoosier stock. He was graduated from Purdue University with the degree of bachelor of science in 1882 and with a degree of master of science in 1884. In 1883 he was given a degree in civil engineering by Iowa State College, and in 1904 Purdue University conferred upon him the degree of doctor of engineering, the first honorary degree to be given by that institution. In 1925 the University of Michigan bestowed upon him an honorary degree of doctor of laws.

In 1886 after serving two years as professor of mathematics, Dr. Mead became professor of irrigation engineering at Colorado Agricultural College, the first such chair to be established in an American school. In addition he served the state of Colorado as assistant state engineer.

He then went to Wyoming as territorial engineer and served the state as its first state engineer from 1888 to 1898. When the new state was being organized, Dr. Mead in his capacity of state engineer proposed an entirely new water law for inclusion in the state constitution, one which turned its back upon the common law principle of riparian rights which had thrown into confusion the legal status of water in the arid west.

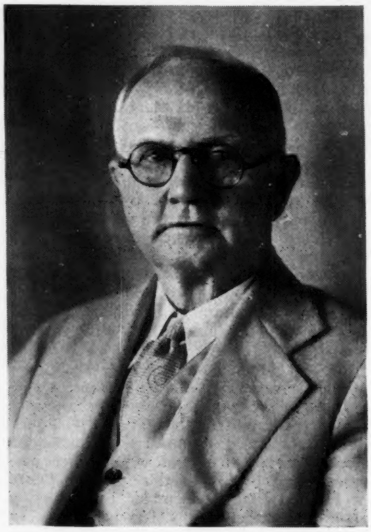
He served as chief of the irrigation and drainage division of the U. S. Department of Agriculture for eight years ending in 1907, and concurrently served the University of California as professor of institutions and practice of irrigation. In 1907 he went to Australia as chairman of the rivers and water supply commission of Victoria, and inaugurated a comprehensive water conservation and reclamation plan in Victoria during his eight years of service that is one of the models of the British Empire today.

Upon returning to the United States in 1915 Dr. Mead resumed his teaching at the University of California, becoming professor of rural institutions. He also served as chairman of the California State Land Settlement Board. He left the University in 1924 when President Coolidge appointed him Commissioner of Reclamation.

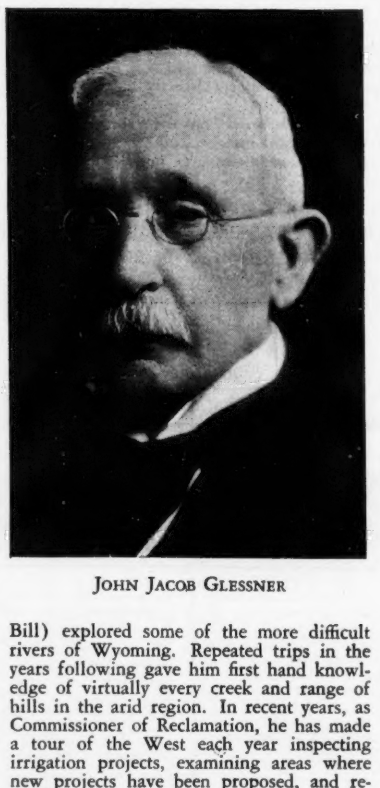
In 1923 Dr. Mead was appointed by the Secretary of the Interior as a special advisor on reclamation to serve with four others on the fact finding commission set up to investigate federal reclamation projects. The commission's report was the basis for reforms put in effect by Congress by the omnibus Reclamation Act of 1924.

Dr. Mead has been loaned to foreign governments in need of expert advice on water and irrigation problems. He went to Palestine to advise the Zionists upon the problems involved in reclaiming the arid lands of the Holy Land; he served on commissions in Cuba and Haiti, and acted as adviser to the government of New South Wales, Canada, Hawaii, Java, and Mexico.

Perhaps no man knew the terrain of western United States better than he. In 1888 he and William F. Cody (Buffalo Bill) explored some of the more difficult rivers of Wyoming. Repeated trips in the years following gave him first hand knowledge of virtually every creek and range of hills in the arid region. In recent years, as Commissioner of Reclamation, he has made a tour of the West each year inspecting irrigation projects, examining areas where new projects have been proposed, and renewing acquaintances which were to be found in every hamlet from Denver to San Francisco and from Spokane to El Paso.



DR. ELWOOD MEAD



JOHN JACOB GLESSNER

Dr. Mead's administration of the Bureau of Reclamation was businesslike and humane. He introduced several reforms, one of the most important of which was the establishment of a policy of selecting settlers for new federal reclamation projects on the basis of their qualifications for irrigation farming. Irrigation farming, he believed, required a high degree of skill for success. He took great pride in the development and growth of communities and cities on federal projects in the West.

In addition to being an Honorary Member of ASAE, Dr. Mead was a member and past-director of the American Society of Civil Engineers, a member and past-president of the American Society of Engineers, and a member of the British Institute of Civil Engineers. He was a member of the Water Resources Committee of the National Resource Committee and served on many other governmental committees and commissions. He was the author of two books used widely as texts: "Helping Men Own Farms," and "Irrigation in the Institution."

John Jacob Glessner

JOHN JACOB GLESSNER, a director of the International Harvester Company, passed away at his home in Chicago, January 20.

Mr. Glessner was an Honorary Member of the American Society of Agricultural Engineers, having been elected to that honor in 1928.

Mr. Glessner was born in Zanesville, Ohio, January 26, 1843, and his entire business career was spent in the farm equipment manufacturing industry, dating from 1863, when at the age of 20 he began work at Springfield, Ohio, in the office of Warder & Childs, builders of reapers, plows, and cotton planters. A few years later he became a partner in the firm, which was a predecessor of the company he eventually headed. In 1866 the firm was reorganized as Warder, Michell & Company, with Mr. Glassner and A. S. Bushnell as silent partners. In 1879 the firm of Warder, Bushnell & Glessner was formed. Mr. Glessner, who had been cashier and head of the office force at Springfield, was then transferred to the firm's Chicago office.

When the International Harvester Company was formed in 1902, one of the five farm equipment concerns which united to form that company was Warder, Bushnell & Glessner, headed by Mr. Glessner. He had been a director of the Harvester Company since its formation, a vice-president until his resignation from that office in 1919, and chairman of the executive committee from February 1904 to November 1906.

Benjamin J. Kough

BENJAMIN J. KOUGH, manager of the John Deere Plow Works, and director of Deere & Company since 1924, passed away January 16. He has been associated with the Deere organization since 1904, starting as a punch press helper. After various shop experience he was appointed secretary to the superintendent, later being appointed assistant superintendent of the plow works. In 1916 he was made superintendent of the John Deere Spreader Works and a year later became manager. Three years later he was placed in charge of the plow works, which position he has since held. He is survived by his widow, a son, and a brother.

NEWS

Washington News-Letter

THE following is an account of its 16th annual meeting furnished by American Engineering Council:

Delegates from the forty-two member organizations of American Engineering Council (of which ASAE is a charter member) meeting in Washington, January 10 and 11, discussed the growing evidence of unity in the profession as to the formulation and dissemination of opinion on matters of public affairs. The Assembly acted upon reports from sixteen major and minor committees and subcommittees of the Council, listened to stimulating addresses at the all-engineers dinner attended by some 450 engineers, and left Washington with renewed expressions of the opportunities for advancing the public interest and for maintaining high professional standards through the agency of American Engineering Council.

At the morning session at the Mayflower Hotel, January 10, President J. F. Coleman opened the meeting with an address on the essential elements in reviving the construction industry. Then followed in order a series of reports and discussions covering a wide range of subjects of timely interest to engineers.

Survey of the Profession. George T. Seabury, as chairman of the Engineering and Allied Technical Committee, reported on the "Survey of the Engineering Profession" conducted by the Bureau of Labor Statistics of the U. S. Department of Labor. His report, based on returns from more than 60,000 questionnaires, the largest survey of this kind ever conducted, indicated that the findings would tend to give direction to engineering education, to choice and distribution of occupation, and to compensation of engineers. It is expected that full returns will be available in the early spring. It was voted to recommend to the Executive Committee of Council that steps be taken toward private publication of a mass of detailed information to supplement the government report.

Dr. Leonard D. White, U. S. Civil Service Commissioner, discussed the needs for a widely extended civil service to include state and local governmental bodies as well as federal, in order to uphold the professional standards of engineers in the public service. Discussion developed that classification by position is essential in the development of a suitably paid civil service. It was voted to instruct the Executive Committee to take the steps necessary to put these basic concepts into action, especially in cooperation with local and state engineering societies.

Economic Balance Toward Higher Standards. Ralph E. Flanders presented the third progress report of the Committee on the Inter-Relation of Production, Distribution, and Consumption. In 108 classified questions and answers, there was presented a catechism on the engineers' concept of the possibilities of an economic balance in the interests of a high standard of living for all. The report was accepted with the recommendation of the Committee that all delegates study it, secure local discussion on its major objectives and detailed recommendations, and report back February 1, with the plan of presenting the report publicly as soon as possible thereafter as the engineers' contribution to our national welfare.

Charles W. Eliot, II, executive officer of the National Resources Committee of the federal government, discussed the purposes and plans of that body in forwarding a state and local as well as a federal concept of planning. The need of approaching planning from a local and regional viewpoint was especially emphasized. It was voted to refer the bill (S-2825) now before the Senate, providing for the continuation of the federal organization on a permanent basis, to the Public Affairs Committee of Council for recommendations.

Public Affairs Reports. The Public Affairs Committee of American Engineering Council, under the chairmanship of F. J. Chesterman of Pittsburgh, has been organized under a new plan during the past year with several subcommittees active in studying public problems which fall within the purview of the profession. For coordination, the subcommittee chairmen are members of the national committee, and steps are being taken to make the membership of subcommittees overlap with that of similar committees of national, state, and local engineering societies. As a result of this work, the reports rendered at the annual meeting cover basic findings in a broad variety of fields.

The Subcommittee on the Administration of Public Works, F. M. Gunby, chairman, reaffirmed Council's past position that engineering public works of the federal government, in so far as practicable, should be concentrated under one qualified head.

The Water Resources Committee, headed by W. S. Conant, reiterated its belief in two fundamental needs for the formulation of a water resources policy: (1) complete and coordinated basic data bearing on the subject and (2) comprehensive study of water control legislation. The establishment of a body similar to the Board of Surveys and Maps of the federal government for the correlation of government data on water resources was recommended.

As a result of the work of the aeronautics subcommittee, headed by Grover Loening, the Public Affairs Committee adopted a report supporting aeronautical research by the colleges, disfavoring further investigations of the industry, recommending further studies toward the simplification of aircraft construction regulations, and favoring the placement of employes of the Bureau of Air Commerce under civil service.

The Committee on Competition of Government with Engineers in Private Practice, under the chairmanship of Alonzo J. Hammond, advocated the curtailment of competitive activities by government and the raising of consulting fees by public bodies comparable to private practice.

Rural Electrification. R. W. Trullinger of the U. S. Bureau of Agricultural Engineering reported on the activities of a subcommittee, made up of members of the American Society of Agricultural Engineers, a member body of Council, to forward the rural electrification program through the aid of engineers. It was voted that this work continue under a committee representative of the profession as a whole.

Patents. The Assembly received a report of the Committee on Patents, Dean A. A. Potter, chairman, dealing with the elimination of fraudulent practices, the use of a single signature on patent applications, the validation of joint patents, and the extension of the full rights of inventors. In addition, several specific items of legislation were presented as under consideration by the committee. It was recommended that the work of the committee be continued.

Mapping. The Assembly adopted the recommendations of the Executive Committee that American Engineering Council establish a new committee on mapping and surveys, and that it endeavor to organize public opinion as to the basic need for completing the map of the United States.

It was voted to support the original Temple Act to the end that its purposes be effectuated by appropriations based upon the fundamental values of mapping and not on a relief basis.

Good Fellowship Dinner. The annual all-engineers dinner of Council, held on the evening of January 10, filled the main ballroom of the Mayflower Hotel. Some 450 engineers, representing all the major branches of the profession, were in attendance. Dr. Harrison E. Howe, editor, Industrial & Engineering Chemistry, proved a brilliant toastmaster.

Following the dinner, an engrossed resolution was tendered to J. F. Coleman in appreciation for his services as president of Council during the past two years. Dr. William McClellan, president of the Potomac Electric Power Company and chairman of the dinner committee, made the presentation. He told how Mr. Coleman had been successful in carrying Council through a critical period in its history. Dean A. A. Potter was introduced as the new president of Council. He stressed the need for solidarity of engineering opinion.

Dr. William F. Durand, chairman of the Third World Power Conference, past-president of ASME, and John Fritz Medalist for 1935, discussed the deeper functions of the engineer. He stated that engineers are the custodians of natural resources such as minerals, coal, and oil, but are not fully living up to their responsibility in conserving these resources. The profession, he said, must concern itself not alone with technical matters but increasingly with human and social problems.

Ralph E. Flanders, past-president of the ASME, directed his remarks toward a reply to a recent address by Walter Lippman before the American Medical Society. Mr. Lippman had stated that the engineer is a

ASAE Meetings Calendar

30th annual meeting—Stanley Hotel, Estes Park, Colorado, June 22 to 25, 1936.

master of material resources, but that the application of his material concepts do not work in solving human problems. Mr. Flanders stated that on the contrary every phase of the engineer's work is intensely human in its application and relationships. He predicted that engineering technique will carry the nation far beyond the "miserable physical standards of 1929."

The meeting was addressed also by presidents or secretaries of each of the seven national engineering societies holding memberships in Council, and by the chairman of the Sixth Conference of the Secretaries of Engineering Societies. Those present were unanimous in affirming their support to the continued leadership of Council as a unifying influence in engineering affairs.

New Officers. Council's new president for 1936 and 1937 is Dr. A. A. Potter, dean of the schools of engineering, Purdue University, who succeeds J. F. Coleman of New Orleans. New vice-presidents are Ralph E. Flanders, president of the Jones & Lamson Machine Co., for a two-year term; and J. S. Dodds, professor of civil engineering, Iowa State College, for a one-year term. Frederick M. Feiker was reelected as executive secretary.

Secretaries' Conference. Preceding the meeting of the Assembly of American Engineering Council, there was held on January 9 the Sixth Conference of Secretaries of Engineering Societies. Some thirty national, state, and local societies were represented. The morning program developed the possibilities and opportunities for cooperation and coordination on matters of public affairs through state societies, national societies, and the American Engineering Council.

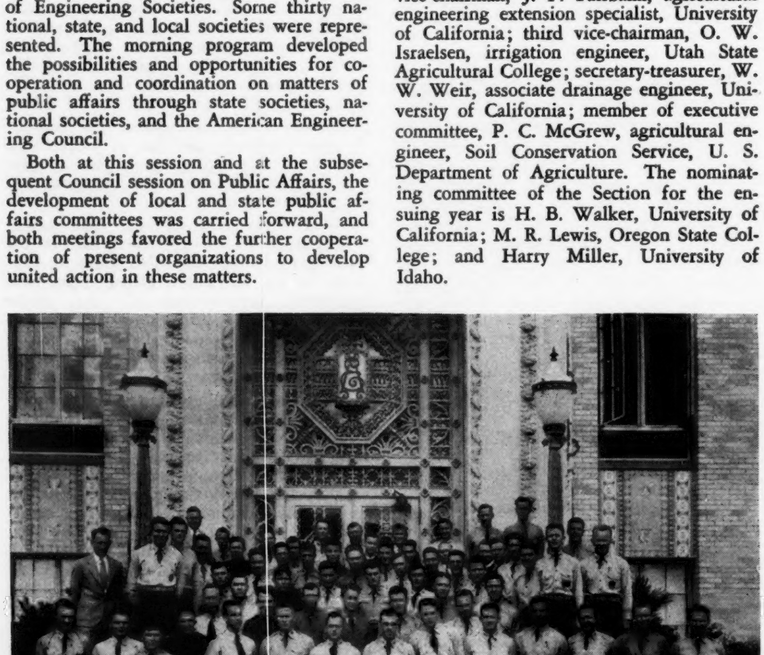
Both at this session and at the subsequent Council session on Public Affairs, the development of local and state public affairs committees was carried forward, and both meetings favored the further cooperation of present organizations to develop united action in these matters.

Speakers at the secretaries' conference included: J. F. Coleman, on progress in engineering organization; General R. I. Rees, of New York, on opportunities for unity among engineering organizations; and Col. J. M. Johnson, assistant Secretary of Commerce, on the engineer in government and business. Other topics included cooperation with national, state, and local secretaries; employment activities; engineering publicity; non-technical programs; and engineering society management.

On adjournment of the secretaries' conference, an informal tea and reception was held at the home of Mr. and Mrs. F. M. Feiker in honor of Mr. and Mrs. J. F. Coleman and Dean A. A. Potter.

Pacific Coast Section Officers

AT THE 14th yearly meeting of the Pacific Coast Section of the American Society of Agricultural Engineers, held at Davis, California, January 9 and 10, new officers of the Section were elected as follows: Chairman, Mark R. Kulp, assistant professor of agricultural engineering, University of Idaho; first vice-chairman, W. J. Gilmore, professor of agricultural engineering, Oregon State College; second vice-chairman, J. P. Fairbank, agricultural engineering extension specialist, University of California; third vice-chairman, O. W. Israelsen, irrigation engineer, Utah State Agricultural College; secretary-treasurer, W. W. Weir, associate drainage engineer, University of California; member of executive committee, P. C. McGrew, agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. The nominating committee of the Section for the ensuing year is H. B. Walker, University of California; M. R. Lewis, Oregon State College; and Harry Miller, University of Idaho.



MEMBERS OF ASAE STUDENT BRANCH AND STAFF MEMBERS OF THE AGRICULTURAL ENGINEERING DEPARTMENT AT THE A. & M. COLLEGE OF TEXAS

Texas A. & M. Student Branch News

THE ASAE Student Branch at the A. & M. College of Texas has one of the largest enrollments of any agricultural engineering student branch in the United States. There are 107 students specializing in agricultural engineering with over half of this enrollment belonging to the Branch, and the membership is steadily increasing.

The agricultural engineering department at Texas A. & M. is one of the best equipped departments in the country. It is housed in a new, modern $190,000 building, which provides the department with special laboratories for farm machinery, farm motors, farm shop, automotive equipment, farm home utilities, and farm buildings. This building is also equipped with indirect lighting and modern fixtures in every class room, lecture room, and laboratory. The new building and equipment has contributed much, along with the increasing demands for agricultural engineers, to the increased enrollment and interest in agricultural engineering at our institution.

The officers of the Branch this year are E. H. Schultis, president; J. F. Roberts, vice-president; and W. G. Lucey, secretary and treasurer. These officers, along with a number of standing committees, have been doing much to make this year one of the best years since the Branch was organized.

The Branch has held four meetings so far this year. At the first meeting which was held on October 10, Prof. F. R. Jones gave many helpful suggestions on conducting programs and activities for the coming year. Plans for a number of activities were made and committees were appointed. It was decided to have a number of picnics and banquets during the year and also plans were made to hold a dance in March. The proceeds will go to sponsor a trip for some of the students to attend the ASAE annual meeting at Estes Park, Colo., in June.

On October 26 the Branch had its first picnic. Around thirty-five members traveled to Scoates Farm in two of the department trucks, and were served some excellent food including some good old-fashioned barbeque. After lunch was served the members sat around the fire and had a good discussion of all the late topics of the day.

On October 31, E. P. Kiser gave an interesting talk on the history of the American Society of Agricultural Engineers, and Joe Krizek made a talk on parlimentary law, from which many useful facts were obtained.

At the meeting on November 14, Mr. Donald Christy showed a number of reels of pictures for the purpose of illustrating government soil erosion control work, and from these pictures many interesting and educational facts were learned.

At the meeting on December 10, plans were made to compete in the FEI cup contest, and the members were very enthused and showed much interest in the contest.

The Branch is looking forward to having a number of prominent agricultural engineers visit it and is also planning on having a good representation at the annual student conference to be held in connection with the ASAE annual meeting in June.

The Branch extends an invitation to anyone interested in agricultural engineering to visit it whenever in Texas.—Clayton B. Lyle, scribe.

Iowa Student Branch News

THE Iowa Student Branch of the American Society of Agricultural Engineers held their second monthly meeting on January 16, and it was one of the best that has been held this school year. The main speaker of the evening was C. H. Chase, secretary, Iowa Implement Dealers' Association. He gave a most interesting talk on the retail implement business and the part which the agricultural engineer has in this program. He stressed the importance of trained engineers in this field which heretofore has been handled by salesmen who have no training in the mechanics of machines, and showed how good managing by trained men would improve the business for both the dealer and the farmers. After a brief talk by Dr. J. B. Davidson, the head of the agricultural engineering department, and a bit of refreshment in the form of a glass of cider and a handful of pretzels, the meeting was adjourned.

The members of the Branch have been working on a display to be placed in one of the show windows of the Memorial Union, and it looks as if the result would be a very interesting and educational exhibit.—Geo. Dunkelberg, scribe.

Personals of ASAE Members

A. D. Edgar, associate agricultural engineer, division of structures, Bureau of Agricultural Engineering, U. S. Department of Agriculture, is one of the author's of Farmers' Bulletin No. 1751, entitled "Roofs Coverings for Farm Buildings and Their Repair," just published.

O. C. French, instructor in agricultural engineering and junior agricultural engineer in the agricultural experiment station, University of California, is one of the editors of Bulletin 596, entitled "Sulphuric Acid for Control of Weeds," recently issued.

V. R. Hillman was recently appointed chief agricultural engineer (Virginia project), Soil Conservation Service, U. S. Department of Agriculture, and is located at Danville, Virginia. Previous to his appointment he was a member of the agricultural engineering staff at Virginia Polytechnic Institute.

Carl A. Johnson has been appointed sales manager for the implement and industrial division, Motor Wheel Corporation, Lansing, Michigan. For twelve years, 1918 to 1930, he was associated with the Hyatt Roller Bearing Company as sales engineer in the farm implement bearings field.

James H. Lillard has been appointed assistant agricultural engineer, Virginia Agricultural Experiment Station, to make studies on soil and water conservation. He was more recently connected with the USDA Soil Conservation Service.

H. B. Roe and *J. H. Neal,* agricultural engineers, Minnesota Agricultural Experiment Station, are joint authors of Special Bulletin No. 149, entitled "Farm Drainage Practice," recently issued by the agricultural extension division of the University of Minnesota.

J. P. Schaenzer has been appointed chief of the electrical installations unit of the project development section, Rural Resettlement Administration, Washington, D. C. Until recently he held the position of agricultural and irrigation engineer of the National Power Survey, Federal Power Commission.

H. P. Smith, chief, agricultural engineering section, Texas Agricultural Experiment Station, and *M. H. Byrom,* agricultural engineering department, A. & M. College of Texas, are two of the authors of Bulletin No. 511, entitled "Progress in the Study of the Mechanical Harvesting of Cotton," recently issued.

Frank. J. Zink has resigned as associate professor of agricultural engineering at Kansas State College to become assistant to H. C. Merritt, general manager, tractor division, Allis-Chalmers Manufacturing Company. He will engage in research and development work for the company with headquarters at Milwaukee. Mr. Zink is an agricultural engineering graduate of Iowa State College, and is at present chairman of the Power and Machinery Division of the American Society of Agricultural Engineers.

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the January issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Julian D. Clement, assistant agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Box 186, Lancaster, S. C.

G. Wallace Giles, assistant professor of agricultural engineering, North Carolina State College, Raleigh, N. C. (Mail) 3151 Stanhope Ave.

Robert A. Jones, secretary, Farm Equipment Institute, 608 S. Dearborn St., Chicago, Ill.

R. Henry Jones, graduate assistant in agricultural engineering, Clemson Agricultural College, Clemson, S. C.

John W. King, superintendent, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Box 127, Kingman, Kans.

Charles E. Louden, technical foreman, Soil Conservation Service, U. S. Department of Agriculture. (Mail) SCS Camp Ia-12, Moorhead, Iowa.

C. C. Ricker, associate agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Davis Apts. No. 6, Paducah, Ky.

George A. Sawin, assistant manager, central station sales, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

Henry W. Scott, engineering aide, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Box 931, Emmett, Idaho.

N. W. Smith, engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Harrisonburg, La.

Robert G. White, junior agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Box 235, Bethany, Mo.

Milo B. Williams, assistant regional chief of project development, Resettlement Administration. (Mail) 2646 Hillegass Ave., Berkeley, Calif.

Transfer of Grade

H. N. Stapleton, extension agricultural engineer, University of Vermont, Burlington, Vt. (Mail) 481 Main St. (Junior to Associate Member.)

The Bureau of Agricultural Engineering

(Continued from page 77)

the staff. The librarian prepares many bibliographies on agricultural engineering subjects and publishes monthly a review of current literature of interest to agricultural engineers.

The extension activities of the Bureau are carried on in cooperation with the Extension Service of the Department. The purpose of this work is to keep the extension agricultural engineers in the various states informed of the results of the research work of the Bureau and to assist them wherever possible in organizing and coordinating their activities.

In the Division of Plans and Service, Mr. M. C. Betts is in charge of the section dealing with requests for plans for buildings and other structures and for the supplying of requested information on a wide variety of subjects. Mr. J. E. Miller is in charge of the architectural section which prepares plans and supervises the construction of buildings for the various bureaus of the Department of Agriculture. During the fiscal year 1935 this section provided plans and buildings estimated to cost over 2¼ million dollars in connection with the Department's building program. Mr. W. E. Hall is in charge of engineering work in connection with the development of migratory bird refuges for the Bureau of Biological Survey.

The research work of the Bureau is carried on by the Divisions of Irrigation, Drainage, Mechanical Equipment, and Structures, and by the Sections of Mechanical Processing and Farm-Operating Efficiency Investigations. The ECW camps engaged on drainage work are under the direction of the Drainage Division.

On the chart there is shown, under each of the research divisions, a list of the current research projects. These are known as "appropriation" projects, and some of them have been broken down into several "work" projects. It is planned to present a detailed study of the work of each of the research divisions in later articles.

Since the work began in 1899 the Bureau and its predecessor organizations have issued some 375 publications dealing with agricultural engineering subjects. Since August 1931, the Bureau has issued "Current Literature in Agricultural Engineering." The following publications for the past month will be mailed upon request:

- Farmers' Bulletin 1749, "Modernizing Farmhouses"
- Annual Report of Chief of Bureau (for 12 months ending June 30, 1935)
- History of the Plow (mimeographed)
- History of Cultivators (mimeographed)
- History of Corn Planters (mimeographed)
- History of Grain Drills (mimeographed)
- Bibliography on Rural Water Supply (mimeographed).

Address all inquiries to the Chief, Bureau of Agricultural Engineering, U. S. Department of Agriculture, Washington, D. C.

Agricultural Engineering Digest

A review of current literature by R. W. TRULLINGER, senior agricultural engineer, Office of Experiment Stations, U. S. Department of Agriculture.

LIGHTING CALCULATIONS, *H. H. Higbie*. New York: John Wiley & Sons. London: Chapman & Hall, 1934, pp. IX + 503, figs. 115. This book contains chapters on illumination and light flux, candlepower and point source of light, brightness, surface sources of light, linear sources, multiplying light by reflections in an enclosure, utilization coefficient—efficiency of the lighting system, lamps—light generators, and visual effectiveness of lighting.

A SOIL MOISTURE METER DEPENDING ON THE "CAPILLARY PULL" OF THE SOIL, WITH ILLUSTRATIONS OF ITS USE IN FALLOW LAND, GRASS ORCHARD, AND IRRIGATED ORCHARDS, *W. S. Rogers* Jour. Agr. Sci. [England], 25 (1935), no. 3, pp. 326-343, pl. 1, figs. 7. In a contribution from the Horticultural Research Station, East Malling, Kent, England, a soil moisture meter which gives direct and continuous measurement of the soil moisture content is described. The instrument consists of a special porous pot filled with water, connected by a tube to a mercury manometer. The pot is buried in the soil whose capillary pull causes the mercury to rise. The height to which the mercury rises depends on the amount of moisture in the soil, and also on the size of soil particles and the degree of compactness of the soil. (The last two factors remain constant for an instrument in one position.) To read actual moisture percentage each instrument has to be calibrated for the soil in which it is placed. Once this is done, all sampling and weighing is eliminated. The range of the instrument in its present form runs from saturation to about 1.5 per cent moisture (calculated on dry weight) in sand, to about 8 per cent in light loam, and to about 21 per cent in heavy clay. Within this range increases and decreases of soil moisture are recorded rapidly and consistently. This type of moisture meter is prevented from giving absolutely precise readings of the soil moisture content owing to the fact that the moisture : pressure-deficiency curve tends to form a hysteresis loop, i.e., does not follow exactly the same course for rising moisture as for falling moisture. The degree of accuracy appears to be sufficient for many purposes, however, for the variability is usually within 10 per cent. Special devices are used to prevent freezing and enable the instrument to give a record over long periods without attention in the field.

Examples of the working of this moisture meter in the laboratory and in the field are given. Instruments placed at different depths in clean cultivated land and in grass orchards showed the contrast between loss of water by evaporation, which hardly affects the soil moisture at 30 inches and loss by root absorption which draws on the deeper layers as well as the surface layers of the soil. In an irrigated orchard the meters showed the penetration of irrigation water and the drying out of the soil at various depths.

An appendix describes the design and construction of the meter found most satisfactory under field conditions.

THE STRENGTH OF MONOLITHIC CONCRETE WALLS, *F. E. Richart* and *N. M. Newmark*. Ill. Engin. Expt. Sta. Bul. 277 (1935), pp. 36, figs. 11. The tests reported were made in cooperation with the Portland Cement Association for the purpose of obtaining information on the strength and stability of monolithic concrete walls of types used in concrete house construction. The investigation was of the nature of a reconnaissance of the field rather than a detailed study.

Tests were made on panels of single and double walls of various thickness, made on dry-tamped concrete, and constructed in successive courses. Tests were also made on ribbed walls consisting of a slab and vertical ribs constructed as a single unit, and on single walls of the same size and shape as the dry-tamped single walls, all made of poured concrete. Eighteen large and 6 small wall panels and 2 ribbed walls were tested with a uniformly applied axial vertical load. Two ribbed walls were tested with an eccentric load, and 7 walls were tested in flexure.

It was found that the compressive strength of all axially loaded walls varied from 1,530 to 4,380 pounds per square inch of loaded wall. The wall strength was affected to a slight extent by the type of wall, whether single, double, or ribbed, and to a very great extent by the strength of the concrete composing the wall. The compressive strength of all axially loaded walls, large and small, was over 55 per cent of the strength of the concrete control cylinders and averaged about 78 per cent of the cylinder strength. Only the 6-inch single walls had a strength equal to the control cylinder strength, although two 4-inch walls approached the cylinder strength very closely. None of the double walls was as strong relatively as the thickest solid walls, considering that only one of the double walls was loaded. The strongest double walls averaged about 82 to 84 per cent of the cylinder strength. There was apparently some weakening effect due to the manner of placing of the ties. The double 3-inch walls were distinctly the weakest walls tested in comparison to the cylinder strengths.

From the small number of tests no definite conclusion as to the relative strength of large and small walls may be drawn. Apparently the large walls developed about the same relative strength as the small walls of the same thickness. The modulus of elasticity of the concrete in the walls was in general about the same as has been observed previously for concrete of the same strength. The modulus varied from 2,400,000 pounds to about 6,000,000 pounds per square inch for concrete strengths of 1,730 to 5,850 pounds per square inch. The flexural strength of the dry-tamped walls was evidently dependent upon the adhesion between courses, and was least where the courses were constructed 12 hours or more apart. Values of modulus of rupture varied from 60 to 130 pounds per square inch for these walls. The flexural strengths of the solid-poured wall and the ribbed walls were not sensibly different from beam strengths of beams of similar section when all the elements involved were evaluated. Assuming failure in flexure to take place at the maximum moments recorded in the test walls, and further assuming construction joints in the dry-tamped walls at midheight, the lateral loads that would cause failure of the walls on a 9-foot story height are as follows: For solid 4-inch walls of dry-tamped concrete 18 pounds per square foot, for double 4-inch walls of dry-tamped concrete 72 pounds, for 4-inch solid-poured walls 108 pounds, and for ribbed walls about 200 pounds per square foot.

The eccentrically loaded ribbed walls were able to carry only 20 to 30 per cent as great a load as the axially loaded ribbed walls. The eccentricity was very high, almost four-tenths of the total depth of the section. Heavier rib sections might very profitably be used in walls of this kind as well as special details for minimizing the eccentricity of loading.

PRESENT PRACTICE WITH REFRIGERATOR CARS: OUTLINE OF INVESTIGATIONS BY THE UNITED STATES DEPARTMENT OF AGRICULTURE IN FRUIT AND VEGETABLE TRANSPORT, *W. V. Hukill* and *D. F. Fisher*. Refrig. Engin., 30 (1935), no. 2, 75-78, 104, 105, figs. 2. A brief outline is given of investigations being conducted by the USDA Bureau of Agricultural Engineering and Plant Industry.

SEWERAGE AND SEWAGE TREATMENT, *H. E. Babbitt*. New York: John Wiley & Sons. London: Chapman & Hall, 1932, 4, ed., pp. XV + 596, figs. 179. This is the fourth edition of this book. In its revised form it contains chapters on work preliminary to design, quantity of sewage, hydraulics of sewers, design of sewerage systems, appurtenances, pumps and pumping stations, materials for sewers, design of the sewer ring, excavation and backfilling, trenching and tunneling, construction of sewers, maintenance of sewers, composition and properties of sewage, disposal by dilution, screening and sedimentation, septicization, filtration, the intermittent sand filter, activated sludge, sludge, miscellaneous processes of sewage treatment, industrial wastes, and a comparison of the processes of sewage treatment.

MECHANICAL CULTIVATION IN INDIA, *C. P. G. Wade*. Imp. Council Agr. Res. [India], Sci. Monog. 9 (1934), pp. IX + 124, pls. [12]. A history of large scale mechanical cultivation experiments is presented. These have related to weed control and plowing especially and have involved the operation of several plowing projects in major agricultural regions. Descriptive information is also presented relating to different tractor and plow types and the development and adaptation of the latter.

Three appendixes give cost data on the different plowing projects, specifications for kerosene and Diesel tractors, and a special report on tractor plowing experiments. *(Continued on page 84)*

Agricultural Engineering Digest

(Continued from page 82)

MORE TRACTORS ON U. S. FARMS. Impl. and Tractor, 50 (1935), no. 15, p. 11, fig. 1. Data secured by the Farm Equipment Institute are reported indicating that there has been a steady increase in the number of tractors on farms in the United States during the past 10 years, even during the depression years.

The Institute estimates that there were 1,123,251 tractors on farms on January 1, 1935, as compared with 920,032 on January 1, 1930, an increase of about 22 per cent. It also estimates that this number has been increased to 1,174,889 as of July 1 this year.

REPORT OF COOPERATIVE DRAIN TILE LABORATORY, *D. G. Miller*. Minn. Dept. Conserv. Bien. Rpt., 2 (1933-34), pp. 39-48, figs. 7. A brief sketch of the history of the laboratory and its work is presented. The work is conducted cooperatively by the Minnesota Experiment Station and the USDA Bureau of Agricultural Engineering.

CATALOG OF FARM BUILDING AND EQUIPMENT PLANS, *J. D. Long*. Davis: Calif. Univ., 1934, pp. [101], figs. 90. This book has been prepared primarily to serve as a catalog of the farm building and equipment plans available through the Agricultural Extension Division, University of California. A short description of the method of using the structure, the construction, and the approximate erection cost are given for each plan illustrated. A bibliography of other sources of farm building information and certain data sheets of general interest are included with the plan sheets.

THE HARVESTING AND DRYING OF CROPS BY THE TRIPOD AND OTHER METHODS, *J. M. Templeton*. Jour. Inst. Brewing, 41 (1935), no. 5, pp. 212-218, figs. 4. Both natural and artificial methods of drying crops are briefly described.

INVESTIGATIONS ON GRAIN BLOWERS AND THE BASIS FOR THEIR DESIGN, *G. Segler*. Untersuchungen an Kornergeblasen und Grundlagen fur ihre Berechnung. Mannheim: Author, 1934, pp. 59, figs. 82. A series of technical investigations are reported in which emphasis was placed upon the relationship between air pressure and velocity in grain blowers and the injury to the germinating properties of seed grain. A large amount of data are presented and discussed. An appendix relates to the mathematical and physical technic employed in the experiments.

DIRECTORY OF APPROVED GAS APPLIANCES AND LISTED ACCESSORIES, June 1, 1935: supplement to April 1 issue. Cleveland, Ohio: Amer. Gas Assoc., Testing Lab., 1935, pp. 7. The appliances listed herein are those which were approved, listed, or added to the Directory of Approved Gas Appliances and Listed Accessories during the month of May 1935.

A TEXTBOOK OF APPLIED HYDRAULICS, *H. Addison*. New York: John Wiley & Sons, 1934, pp. XII + 409, figs. [327]. This handbook presents a compact summary of the fundamental principles of hydraulics and of the manner in which they are applied by the engineer. Part 1, relating to fundamental principles, contains chapters on liquids and their properties, static pressure of liquids, flow of liquids through orifices and over weirs, flow of liquids through pipes and along channels, dynamic pressure of liquids, and rotary motion of liquids. Part 2, on practical applications, contains chapters on pipes and pipe systems, control of water in open channels, some automatic control devices, hydraulic turbines—construction, hydraulic turbines—performance, pumping machinery—positive pumps, pumping machinery—centrifugal and propeller pumps, hydraulic transmission and storage of energy, and hydraulic measurements.

EFFECT OF COVER ON SURFACE RUNOFF AND EROSION IN THE LOESSIAL UPLANDS OF MISSISSIPPI, *H. G. Meginnis*. U. S. Dept. Agri. Circ. 347 (1935), pp. 16, pls. 13, figs. 6. The study described in this circular forms a part of a soil erosion and runoff investigation begun by the USDA Southern Forest Experiment Station in 1929 in the silt loam uplands east of the Mississippi River. This section, roughly 500 miles long and from 35 to 100 miles wide, is characterized by widespread erosion of an especially destructive type.

A study was made of surface runoff and erosion from comparable soils representing seven combinations of cover type and land use over a period of 2 years. The measurements were made from 11 small plats laid out on areas having a uniform 10 per cent slope.

Rainfall during the 2 years totaled 130.7 inches and occurred as 103 rains of from 0.03 to 5.32 inches each. About 28 per cent of the precipitation occurred as torrential rainfall and 20 per cent as rains of moderate intensity.

For a plat in a cultivated cotton field in which the rows paralleled the slope, surface runoff amounted during the 2 years to 58 per cent of the total precipitation and in individual rains amounted to as much as 96 per cent of the precipitation. On this plat the rate of soil erosion exceeded 195 tons per acre for the 2 years. For a cultivated cotton field in which the rows paralleled the contour, runoff totaled 47 per cent of total precipitation and soil eroded during the 2 years total 69 tons per acre.

From barren plats in an old field there occurred during the 2 years a total runoff amounting to 48 per cent of the rainfall, and erosion totaling nearly 160 tons per acre.

In two years, the runoff from unburned broomsedge plats in an old field amounted to only slightly more than 1 per cent of the rainfall, and that from oak forest to less than 1 per cent. During no rain did runoff from land of these two classes exceed 5.05 and 3.10 per cent of the rainfall, respectively. Erosion from such lands was almost negligible; the quantity of soil washed from each forest plat was to the quantity lost from one cultivated plat as 1:4,300.

Total runoff and erosion from plats in a plantation of black locust and osage orange, a Bermuda grass pasture, and scrub oak woodland were somewhat larger than these but were very much smaller than those from barren or cultivated land.

The results of the study are particularly valuable in giving a comparison of surface runoff and erosion losses for different types of cover and in indicating the approximate losses that might occur on larger areas or watersheds where the water tends to concentrate into streams.

Because soils having a cover of vegetation absorbed practically all the rainfall, including that of extremely hard rains, and because the soils of the section possess great storage capacity, the general conclusion reached is that in the loessial uplands of Mississippi a plant cover, in addition to preventing abnormal erosion, is of tremendous value in flood control and stream-flow regulation.

GINNING COTTON, *C. A. Bennett* and *F. L. Gerdes*. U. S. Dept. Agr., Farmers' Bul. 1748 (1935), pp. II + 46, figs. 33. This bulletin supersedes Farmers' Bulletin 1465. It discusses methods and equipment for handling and processing seed cotton from the time of harvesting until the lint is baled so as best to retain the desirable qualities of the fibers.

Farm Equipment Research in Europe

(Continued from page 76)

of its kind, has been conducting some experiments in the use of electric power.

The Institute at Oxford has a tractor testing plant in operation. The equipment and technique are not greatly different from that at Nebraska. Among other subjects, the Institute has given particular attention to the use of pneumatic tires for carts and wagons and claims some credit for the extensive use of these tires in Great Britain. Grain drying has been one of the principal subjects for study. The Institute conducts official tests for the Ministry of Agriculture and receives grants of funds from the Ministry for its support. It would appear that the Institute has not as yet fully developed a working plan for cooperation with the manufacturers.

In Spain we found the National Agronomical and Machinery Testing Station of Madrid. The work of this station consists primarily of field tests of machines. One publication has been issued treating of threshers and windrowers. The national college of agriculture has particularly well equipped laboratories. The hydraulic laboratory, newly equipped, is one of the best anywhere. When we visited the station, tests were under way in the laboratory of olive oil as an engine lubricant.

After a visit to the research stations of Europe, the question may well be asked: What can we do to improve our institutions? It seems to me that there are at least three things we should consider most seriously:

1 Seek more cooperation and coordination between public research institutions. *(Continued on page 88)*

Farm Equipment Research in Europe

(Continued from page 84)

2 Develop and define the relationships between manufacturers and public research institutions dealing with farm equipment.

3 Establish the relationship of the public research institutions to the agricultural public on sound principles of best service.

Rate of Wear of Spray-Gun Disks

(Continued from page 67)

disk might be justified. It appears that even a hard disk, such as Stellite, cannot satisfactorily resist abrasion from sandy water. The hardened stainless steel and the Stellite disks do have the advantage of being rust-proof, besides being more resistant to wear. Unless ordinary disks are kept oiled when not in use, rust will form around the orifice and soon ruin it.

The use of water, free of fine sand, will greatly lengthen the life of spray disks. It is suggested that, when elevated water storage tanks are used to fill the spray tanks, they also be used as sediment-collecting tanks. Instead of taking the water out near the bottom of the elevated tank, as ordinarily done, if it is taken out about 12 inches from the bottom, most of the sand or fine grit will have settled to the bottom and will not find its way into the spray tank.

A Correction

IN THE paper, entitled "The Handling, Processing, and Storing of Legume Crops for Feeds," by Howard E. Richardson, beginning on page 469 of AGRICULTURAL ENGINEERING for December 1935 (vol. 16, no. 12), the first sentence of the third paragraph reads: "Ohio studies indicate that hay can be put into storage by the chopper method for 73 cents less per ton than mowing away whole hay." It should have read "for 37 cents less."

EMPLOYMENT BULLETIN

The American Society of Agricultural Engineers conducts an employment service especially for the benefit of its members. Only Society members in good standing may insert notices under "Positions Wanted," or apply for positions under "Positions Open." Both non-members and members seeking to fill positions, for which ASAE members are qualified, are privileged to insert notices under "Positions Open," and to be referred to members listed under "Positions Wanted." Any notice in this bulletin will be inserted once and will thereafter be discontinued, unless additional insertions are requested. There is no charge for notices published in this bulletin. Requests for insertions should be addressed to ASAE, St. Joseph, Michigan.

POSITIONS WANTED

AGRICULTURAL ENGINEER with master's degree in agricultural engineering, and additional training in fundamental sciences, desires position in either teaching or research work. Eight years' experience. Age 32. Married. PW-267.

AGRICULTURAL ENGINEER, with B.S. and M.A. degrees in agricultural engineering, and with several years' experience in civil and agricultural engineering fields, including road and bridge building, farm machinery manufacture, and soil conservation practice, also seven years' reseach experience in agricultural experiment station, principally in electrical equipment, and also teaching experience of farm machinery, engines, shop, and materials of construction, both resident and extension, desires employment in agricultural engineering teaching (resident or extension) or in sales promotion with farm machinery or electric power company. Age 34. Married. PW-268.

POSITIONS OPEN

ENGINEER (preferably agricultural) is offered considerable block of non-assessable stock in a close corporation which controls through strong patents, etc., the manufacture and sale of practical concrete construction specialties of proved utility. This stock can be paid for by development work that need not interfere with the engineer's usual activities. To an ambitious engineer having executive ability, this offers an opportunity to become a high official of a corporation that in due time should become a strong, nationally known firm. PO-112